

NOTES
ON
MILITARY SCIENCE



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Will Wilkins



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✦ NOTES ✦

ON

Military ✦ Science

AND

THE ART OF WAR,

BY

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PREFACE.

THESE NOTES were prepared in an abbreviated form for use in connection with a course of lectures on Military Science and the Art of War delivered to the Senior Class at the State University of Iowa.

The absence of a text-book made something of the kind necessary, and the success that has attended the distribution of hektograph copies of these Notes seems to indicate that they are in the right direction.

No attempt has been made in these lectures, which are supplemental to four years of drill, to teach the purely technical part of the military profession. The limited time available for military instruction at colleges indicated to me that the instruction should be broad and general. The aim, therefore, has been to teach these young men how armies are organized and their affairs administered; how men are handled in actual warfare, and how battles are fought; and, in addition, something about the material employed in war,—guns, ammunition, torpedoes and explosives: in short, to give them a speaking acquaintance with the Science and Art of War.

Nothing especially original is claimed for the subject matter of the book. The authorities consulted have been

so many and various that no attempt has been made to cite them. I am, however, greatly indebted to Captain James Chester, 3d U. S. Artillery, for valuable hints and suggestions, and to 1st Lieutenant D. A. Howard, U. S. Ordnance Department, for important data.

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Nov. 12, 1888.

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Chapter I.

ARMY ORGANIZATION.

A MULTITUDE of men do not constitute an army. Even with arms in their hands and uniforms upon their backs they still may be a mob. The work of converting this human raw material into a fitting instrument of war may be considered under three heads: *Organization, Drill, and Discipline.*

Organization may be said, in a general way, to be the forming from all the elements brought together, one body, every member of which may be instantly put in motion by an impulse communicated from the head. More specifically, it is the division and subdivision of the mass into parts and into units; the fixing of the chain of responsibility from the general-in-chief down to the commander of the smallest sub-division; the *placing* of each man of the multitude, and then providing for his maintenance—for his arms and ammunition, for his food and clothing.

Organization is of two kinds, *tactical* and *administrative*; tactical, that which relates to the prepara-

tion of men for the field of battle; administrative, that which looks to their maintenance in peace as well as in war.

Drill is the familiarizing of the individual soldier with his weapon ; making him acquainted with its capabilities and enabling him to obtain from it its maximum effect, and, in addition, teaching him to act in harmony and intelligently with other individual soldiers to the accomplishment of a common purpose.

Discipline, as understood in a military sense, may be said to be the perfect subordination of each and every individual of the multitude to the will of the superior; the willing, spontaneous and unquestioned obedience of all to the commands of the chief. It is the "seasoning" process for the raw recruit; it is the teaching of that self-control which enables a man to preserve his coolness and equanimity at all times, and under the most startling and unlooked-for conditions

But it takes time and actual experience in the field to make the recruit a valuable soldier. "The value of the veteran consists as much in his habitual expertness in the routine of the camp and the march as calmness and confidence under fire."

Among barbarous peoples all men are warriors, and even in a rude state of agriculture every man may serve a part of the year as a soldier; but a more

civilized state of society and advanced stage in the military art require that a portion of the population should be permanently given to the military service.

There are two general methods, among civilized nations, for obtaining men for an army — by *Conscription* and *Voluntary Enlistment*. Conscription is now the prevailing method among all the great powers—England and the United States alone excepted.

Under the method by conscription, all able-bodied men from about twenty to forty years of age are liable to military duty, with certain exceptions for occupation, etc. A certain number of men, depending on the exigencies of the times, are called for each year, and required to join the colors. The period of service varies from twelve to twenty years, of which time from three to six years are with the colors; then follows about the same period on furlough, or in the first reserve, during which the men may be recalled at any time, after which they pass into the general reserve, and are called into service only in time of great national danger.

The calling in of these furloughed men, and all the preparation necessary to enable them to take the field, is called *mobilization*.

The proportion of the population that can be spared for military service is much greater in a rude

than in a civilized state of society. It is estimated that one per cent. of the population in a modern civilized state may be diverted to military purposes without detriment to other interests.

An army is divided into two general classes—the *Line* and the *Staff*. The *Line* constitutes the fighting force—that is, all officers and men who do the actual fighting. The *Staff* are those employed in an administrative or executive capacity.

The fighting force is composed of three arms—*Cavalry, Artillery and Infantry*. By an *arm* we mean the union of those combatants having the same mode of action.

The Infantry constitutes the main body of an army, and is organized as follows :

The Company is the unit. The number of men per company varies in different services. The war strength of a company in our own service is one hundred; in England, one hundred and twenty-five, while in the German service, and in most other European armies, it is about two hundred and fifty.

The Battalion, of from four to eight Companies, is the *tactical* unit, and is the proper command of a Major. In all armies, except our own, the battalion organization prevails.

The Regiment, in the United States service, is the tactical unit; but in all foreign armies it consists

of from two to four battalions, with a Colonel, a Lieutenant-Colonel and as many Majors as there are battalions. In all European armies there is attached to each battalion, or regiment, one or more "dépot companies," to which all recruits are sent, and where they receive a certain amount of training before being sent to join their companies in the field.

The Brigade consists of two or more regiments, and is the proper command of a Brigadier-General.

The Division consists of two or more brigades of infantry, a certain proportion of artillery and cavalry, a company of engineers, and possibly a signal detachment, and is commanded by a Major-General.

The Corps is composed of two or more divisions of infantry, a division of cavalry, all the reserve artillery, a battalion of engineers, a signal detachment and a bridge train, and is the command of a Lieutenant-General. The Corps is the *strategical* unit. It is, in fact, a small army, complete in all its parts, and capable of independent action.

Two or more Corps would constitute an army, the proper commander of which would be a General.

Artillery. The unit is the Battery, usually of six guns, and, roughly estimated, with twenty horses and twenty-five men per gun. The proportion of artillery varies from two to four guns per thousand

infantry, depending upon the character of the infantry and the theatre of military operations. Poor infantry needs most artillery, and an army operating in a wooded country with poor roads less than if the opposite conditions prevailed.

The artillery belonging to an army is divided into two classes—*Mounted* and *Horse Artillery*. Mounted artillery serves with infantry, the cannoneers riding on the carriages. In the Horse Artillery the guns are lighter, the cannoneers are mounted on horseback, rapid movement is possible, and it is intended to serve with cavalry. Machine-guns would find their proper field in this service.

The artillery allowed to a Corps is divided into two parts. One, usually about half, is attached to the divisions, while the remainder is retained under the direct control of the Corps Commander, and constitutes the Corps Artillery, or the Artillery Reserve.

In addition to the artillery serving with an army in the field, artillery troops for the service of heavy guns in forts, and for siege-guns, will be required. These troops have essentially the same organization as the mounted artillery, but are armed as infantry.

Cavalry. The unit is the *troop*, usually of about fifty men. Two troops form a squadron, and with from four to six squadrons to a regiment. It is grouped into brigades and divisions like the infantry,

with a varying number of sub-divisions to each larger division. The cavalry is usually assigned, as is the artillery, to the divisions of infantry, with a Corps reserve; but it may be formed into a corps by itself.

The Staff of an army consists of —

The Adjutant-General's Department — is the department of orders, correspondence, records and statistics.

The Inspector-General's Department — is the department through which the General watches over the discipline, drill and general efficiency of the troops; it examines the accounts of disbursing officers.

The Judge-Advocate General's Department — is the law department of an army. It advises the General as to the technical correctness of court martial records and rulings; assists him with his advice on all questions of law submitted by him, and represents the United States in all military trials before either military or civil tribunals.

The Quartermaster's Department — supplies the clothing for the men; the horses, mules and wagons; forage for all animals; tents, camp equipage and fuel; has charge of all transportation by land and water, and everything that concerns "the outward comfort of the men or the inward comfort of the

animals" comes within its jurisdiction. It is by far the most complicated and expensive department of an army.

The Subsistence Department — purchases, collects and issues all food for the men, and provides for sale various articles of provision and small stores not on the regular supply tables.

The Medical Department — provides medical supplies of all kinds; has charge of all hospitals and ambulances, and the care of all sick and wounded

The Pay Department — provides for the payment of troops at stated intervals; is charged with the settlement of the money accounts of the soldier; pays mileage accounts, etc.

The Ordnance Department — supplies the arms, ammunition and accoutrements for the infantry-man; the guns, carriages, harness, ammunition and equipments for the artillery and cavalry.

The Engineer Department — is charged with the construction of forts and field works; the preparation of ground for defence; the repair of roads and laying of bridges. Engineer troops have the infantry organization and arms.

The Signal Department — is charged with the erection and maintenance of all field-telegraph lines, and all means for the communication of orders and information between the separated parts of an army.

The Provost-Marshals Department — has an organization only in time of war, and has the care of all prisoners; officiates at executions, and has charge of the detective and secret-service business of an army.

To recapitulate the matter of organization, we have first—

The Company, with a Captain and two or three Lieutenants, one first and four duty Sergeants, four or more Corporals, two Musicians and say eighty-six privates, or a total strength of one hundred.

The Regiment, of ten or twelve companies, with a Colonel, a Lieutenant-Colonel, one or more Majors, an Adjutant, and a Quartermaster, with the rank of First Lieutenant; a Surgeon with the rank of Major, and an Assistant Surgeon with the rank of First Lieutenant, and sometimes a Chaplain with the nominal rank of Captain; a Sergeant-Major, a Hospital Steward and a Quartermaster Sergeant.

The Brigade, of two or more regiments, with a Brigadier-General in command, who has, as his individual staff, an Adjutant-General, a Quartermaster, a Commissary, all Captains, a Surgeon, usually known as the Brigade Surgeon.

The Division, of two or more brigades, commanded by a Major-General, who has the same staff

as a brigade commander, with the possible addition of a Provost-Marshal, and with the exception that the Adjutant-General, Quartermaster and Commissary should have the rank of Major.

The Corps, of two or more divisions, with a Lieutenant-General in command, who would have the same staff as a division commander, with the several rank of Lieutenant-Colonel, and known as the Chief Quartermaster, Chief Commissary, Medical Director and Inspector-General, and, in addition, would have upon his staff the commander of the Corps Reserve Artillery, as Chief of Artillery, and an Engineer officer.

An Army, of two or more Corps, should have a General in command, who would have a staff identical with that of a Corps commander, except that the officers above mentioned should have the rank of Colonel.

The above is given as the proper rank of the various commanders. In our service the rule has never been followed. Washington, Grant, Sherman and Sheridan are the only full Generals we have had, and they also the only full Lieutenant-Generals.

An army Corps of twenty-five thousand men, under our military system, might have the following organization:

Two divisions of infantry, eight batteries of mounted artillery and four of horse artillery, two divisions of cavalry, a battalion of engineers, signal detachment, etc., divided as follows:

<i>Infantry</i> —2 divisions, 6 brigades, 18 regiments, or...	18,000
<i>Artillery</i> —divisional, of 4 mounted and 2 horse batteries, and an equal number as corps artillery, or 72 guns and.....	1,800
<i>Cavalry</i> —2 divisions, each of 2 brigades of 2 regiments of 6 squadrons, or.....	4,800
<i>Engineers</i> —1 battalion; signal detachment, hospital corps, etc.....	400
Total.....	25,000

The army of the United States, as at present organized, consists of—

25 Regiments of Infantry, each of 10 Companies.

10 Regiments of Cavalry, each of 12 Troops.

5 Regiments of Artillery, each of 12 Batteries.

Engineer Battalion, 4 Companies—450 enlisted men.

Ordnance Detachment—400 enlisted men.

Signal Corps—470 enlisted men.

Indian Scouts—300 enlisted men.

Hospital Corps—630 enlisted men.

Non-commissioned staff and privates unattached to regiments—705 enlisted men.

General Service Clerks and Messengers—170.

Rank in the army is fixed as follows:

- | | |
|------------------------|---|
| 1. General. | 13. Regimental Quartermaster-Sergeant. |
| 2. Lieutenant-General. | 14. Ordnance, Commissary and Post Quartermaster |
| 3. Major-General. | Sergeants, Hospital |
| 4. Brigadier-General. | Steward, Chief Musician, Principal Musician, |
| 5. Colonel. | Chief Trumpeter and |
| 6. Lieutenant-Colonel. | Saddler-Sergeant. |
| 7. Major. | 15. First Sergeant. |
| 8. Captain. | 16. Sergeant. |
| 9. First Lieutenant. | 17. Corporal. |
| 10. Second Lieutenant. | 18. Private. |
| 11. Cadet. | |
| 12. Sergeant Major. | |

Its strength is limited by law to 25,000, *exclusive* of the Signal and Hospital Corps.

The military force of the United States consists of the regular army; organized militia or State troops, about 106,000; and the unorganized militia, estimated about 7,900,000.

Chapter II.

ARMY ADMINISTRATION.

ARMY administration relates not only to the questions of supply of an army, but to the entire administration of its affairs in peace as well as in war.

Nothing definite is known of the methods employed in ancient times to supply armies, although for Cæsar it is claimed that he had a commissariat, and did not depend on the foraging of the individual soldier. Still it was almost wholly a commissariat of plunder, although an official, orderly and calculated one. During the Middle Ages armies subsisted, friend and foe alike, from off the theatre of operations. They came together to fight then scattered to subsist. War in those days meant pillage and was cruel to the last degree.

With standing armies, and the necessity of strict discipline, came an organized commiserat. Under Frederick the Great an army became wholly independent of the resources of the invaded territory. Subsisting from an enemy's country is one of the rights of war, but subsisting by pillage is quite a

different thing. In the former case it is done by properly appointed officers and under military restrictions, and the supplies gathered are issued and accounted for in the regular way.

The Staff, as has been said, is charged with the questions of administration and supply. The officers of the Staff departments have, for the furtherance of discipline, military rank, but they never command troops unless specially assigned thereto. When thrown together with troops, an officer of the line, however low his rank, would take command, whatever might be the rank of the other.

Correspondence. All official communications between an inferior and a superior pass through the hands of all the intermediate commanders, and are returned through the same channels. All communications forwarded to a superior are signed by the inferior in person; all those to an inferior in rank are signed by order of the superior, and by his Adjutant or Adjutant-General.

Property Accountability. Every article of public property, however small, issued for use of troops, must be accounted for until properly disposed of; and all officers receiving such property are held to a strict pecuniary and personal responsibility for its safe-keeping. The clothing issued to the men becomes their personal property, under certain re-

strictions; but for the arms, ammunition and equipments, tools and utensils of all kinds, issued for the use of a company, the Captain must receipt and become responsible.

Quartermaster's Supplies for an army in the field are either manufactured by the department, as in the case of clothing and some other articles, or purchased under contract or in open market, and are gathered together in depots and from thence issued to the corps, division or brigade Quartermasters, and by them distributed to regiments, batteries, etc.

Subsistence Stores are purchased by officers of this department, in the large markets of the country, and, like quartermasters' stores, are collected in large quantities at safe points in rear of the army, and from thence issued to the Commissary officers serving with troops in the field.

Under ordinary circumstances, rations are issued to troops every ten days. In campaigns, or when starting on a march, the men carry on their persons two, three and sometimes five days' rations. On marches, whenever practicable, the beef ration is driven on the hoof.

Ordnance Stores, with the exception of powder, which is purchased, are nearly all manufactured

at government arsenals, and, like all other supplies, sent to depots and thence to the front.

The Medical Department is charged with important and exacting duties. The whole fighting power of an army depends on the health of the individual soldier. As has been said, each regiment, or independent organization, has its medical officer and assistants, and at each headquarters the department is represented by an officer of the department.

With each regiment there is a temporary or improvised hospital for the reception and care of those taken suddenly ill, or only likely to be temporarily disabled. With each Corps, usually, there is a Field Hospital, where the more serious cases are taken, and to which are sent the more seriously wounded from the field of battle. Here most of the surgical operations and amputations are performed. Besides the Field, there are General Hospitals, located usually in some city, which receive all the badly wounded and all those likely to require long treatment. Each of these hospitals has a surgeon in charge, with a staff of assistants, nurses and attendants.

On the field of battle, as near the fighting line as may be, the regimental surgeons are ready to give such aid to the wounded as they may at once require: wounds are dressed, bandages applied, and, in case of shattered limbs, amputations performed.

In an infantry company there are four men designated as litter-bearers, whose duty it is to bring back to this point all who are unable to get there by themselves. Here the ambulances are waiting to convey all who are unable to walk to the Field Hospital.

Each of the other staff departments is represented at division, corps and army headquarters by an officer who is charged with the administrative supervision of his own department.

The Organization of Trains, which falls to the Quartermaster's department, is one of the most difficult duties pertaining to the supply of an army. The elements that enter into the problem are the strength and composition of the army; the character and extent of the operations; the nature of the country operated in; the soil, with special reference to the effect of rain thereon; if streams have to be crossed, the possibility of bridges being destroyed, and the time required to repair them. These, and many other elements of uncertainty, must be kept in view, and, as much as possible, provided against.

Separate trains of wagons must be provided for ammunition for infantry, for cavalry, for artillery, for forage, for rations and for baggage. These wagons are divided into two general divisions—*Division* and *Corps Trains*. The former carry such supplies of

ammunition, forage and rations as may be needed at once, and must accompany the troops, while the Corps or Reserve train may move in rear of the army.

An army wagon will carry 2,000 pounds over all roads, and five days' forage for its six mules. One thousand rounds of rifle ammunition weigh about 100 pounds: one wagon will carry 20,000 rounds.

Each soldier should have *at least* 160 rounds,—80 on his person, or immediately available, and 80 in the wagons. With a repeating rifle this number would have to be considerably increased.

The artillery will require 400 rounds per gun—one-half in the chests and one-half in wagons. A round for our 3.2-inch field-gun will weigh about 17 pounds. With 6 guns per battery, each 200 rounds, equal 20,000 pounds—10 wagon-loads per battery. The horse artillery will carry less ammunition; but by removing the rear chests of the caissons, a certain amount of forage can be carried.

Rations. The army ration, exclusive of meat, will weigh, with necessary packages, about two pounds, or one wagon-load per day per thousand men.

Forage: Eight pounds per. day per animal, or four wagons per day per thousand animals.

Baggage: One wagon to each regiment, one to each brigade and division, and two to corps headquarters—thirty-six in all.

An army corps, then, of 25,000 men, organized as we have supposed, to take the field, with proper amount of ammunition and five days' supply of food and forage in its wagons, would require—

For infantry ammunition, 18,000 men.....	72	wagons
For cavalry carbine ammunition, 4,800 men.....	19	"
For artillery ammunition, 12 batteries.....	120	"
For rations for 5 days, 25,000 men.....	125	"
For forage for 5 days, 4,800 horses.....	96	"
For baggage	36	"
	468	

The U. S. Army ration is, by weight :

Meat,	16 oz. average beef and pork.
Flour,	18 oz. or 18 oz. bread in lieu.
Beans,	2.4 oz. or 1.6 oz. rice in lieu.
Coffee,	1.6 oz. or .32 oz. tea in lieu.
Sugar,	2.4 oz.
Pepper,	.04 oz.
Salt,	.6 oz.
Vinegar,	.8 oz.
	2.65 lbs.

Weight carried by soldier in U. S. service, is:

Rifle and bayonet	9.50 lbs.	
Belt	50 lbs.	
80 rounds ammunition.....	8.00 lbs.	
		<u>18.00 lbs.</u>
2 days' full rations.....	5.30 lbs.	
Utensils	3.00 lbs.	
Canteen filled.....	3.75 lbs.	
		<u>12.05 lbs.</u>
1 piece shelter tent.....	2.00 lbs.	
1 blanket	5.20 lbs.	
1 overcoat	8.50 lbs.	
1 pair shoes	3.00 lbs.	
1 pair drawers	.75 lbs.	
1 shirt.....	1.00 lbs.	
1 pair stockings.....	.25 lbs.	
		<u>20.75 lbs.</u>
Total weight carried, fully equipped	50.80 lbs.	
Weight carried by English soldier	57.00 lbs.	
Weight carried by Italian soldier.....	62.00 lbs.	
Weight carried by German soldier	55.00 lbs.	
Weight carried by French soldier	50+ lbs.	

The Roman soldiers are said to have carried a weight of quite 100 pounds, including their provisions, weapons and armor.

Chapter III.

LINES AND ORDERS OF BATTLE.

ANCIENT FORMATIONS.

THE infantry formations of ancient times were in heavy, solid masses, intended to act by shock alone, and with little or no mobility.

Egyptian infantry formed in heavy square battalions of 100 men to a side, or 10,000 in a body, subdivided into fractions of 1,000, 100 and 10. The heavy infantry carried a shield and pike; the light infantry were archers and slingers.

The Jews formed their infantry upon a single line, from 10 to 30 men in depth. The archers and slingers occupied the front rank, the heavy armed troops the rear. The tactical unit seems to have been 1,000 men, sub-divided into groups of 100.

The Persian infantry was originally armed only with offensive weapons, and formed in heavy battalions of 24 to 30 men in depth. Cyrus the Elder reduced the number of ranks to 12, and introduced the use of defensive weapons. Like other early

nations, the Persians followed the decimal system of sub-division, and divided their troops into bodies of 10, 100, 1,000 and 10,000 men.

The organization of the Greek infantry, instead of being decimal, was founded on the powers of the number *two*. The Greek *phalanx* was a corps of heavy infantry, formed in a single line, 16 men deep. Taking as its primitive element a file of 16 men, four of these files, or 64 men, was the unit of organization, corresponding to a modern company. Four of these, or 256 men, were grouped together into a body corresponding to a small modern battalion. The *phalanx* numbered something over 16,000 men, and was the tactical unit. In open order there was an interval of six feet between men each way; in close order, three feet; and in very close order, a foot and a half. The *phalanx* charged in close order, and received a charge in very close order. The heavy infantry was armed with the long pike; the light infantry with short pike and shield, or were archers, slingers, or darters.

The Roman legion formed in three lines, each line of ten companies, of ten ranks and twelve files, or 120 men, except the third line which had but half the number of files. These, with 1,200 light troops or skirmishers, gave the legion a strength of 4,200 men. Later the legion was divided into ten Cohorts,

or battalions. The distance between each soldier was six Roman feet each way (5 feet 7 inches).

The offensive weapons of the Roman soldier were the pike and sword for heavy, and light spears, javelins and darts for light troops. The helmet, breastplate, and shield constituted their defensive arms.

With the introduction of fire-arms, depth of formations decreased. In the time of Henry IV, infantry formed in ten ranks; with Gustavus Adolphus, six ranks; Louis XIV, four ranks; and under Frederick the Great, three ranks.

The Art of War may be considered under five sub-divisions :

1st, Strategy : The art of making war upon the map; the planning of a campaign; and comprehends the whole theatre of operations in an extended sense, and embraces all pre-arrangements of war previous to tactical operations. It admits of success without actual tactical collision.

2d, Grand Tactics : Is the art of moving an army on the field of battle; of posting the troops according to the accidents of the ground; of putting them into action at the proper time. It is the actual fighting upon the ground in contra-distinction to planning upon the map. Its operations may extend over a field miles in extent.

3d, Logistics : Is the art of moving armies, and includes all the means adopted to carry out the plans of Strategy and Grand Tactics; the order and details of marches, camps, quartering and supplying troops. "Strategy decides *where* to act; Logistics brings them to the point, and Grand Tactics decides the manner of execution."

4th, Minor Tactics : The tactics of the three arms; all operations of detachments, such as relate to convoys, foraging, and affairs of advance guards.

The term *Tactics* is often confounded with that of Drill. Tactics mean something more than mere drill. Our name for the manual of the arm and the instruction of troops is a misnomer. It is a *drill-book*, and not tactics, properly speaking. In a broad and true sense, tactics mean the proper methods and means of using troops: how to fit them to the ground they occupy; how and where to post them in any given position so as to obtain the maximum advantage; how to attack or defend such position; the formations of the troops and the regulation of the fire. A perfect drill-master is not necessarily a tactician.

5th, Art of the Engineer : Relates to the preparation of ground either for defense or offense, also the building and destruction of bridges, roads, etc., and the conduct of siege operations.

Line of Battle: Troops placed upon the same line, whether deployed or in column of attack; formed with proper tactical intervals and distances either with or without a particular object in view for the future.

Order of Battle: Is more than a reunion of lines; it is the general and combined disposition of troops of different kinds, grouped together *for a specific purpose*,—including an intention to execute a certain manœuvre.

In the Greek order of battle, the troops were drawn up in two equal and parallel lines. With the Romans it was three lines with intervals, with the veterans in the third line.

With the Franks, and the barbarians who overran the Roman Empire, the order of battle was a compact, wedge shaped mass of men.

With modern tactics as many as twelve different orders of battle have been laid down. There is the *parallel order*, the *oblique order*, the *convex* and *concave order* as the principal ones. These terms have reference either to the relative positions of the opposing forces, or to the peculiar formation of either the attack or defense. Under the present conditions of warfare the advantages claimed for any of the old orders of battle, for the attack, at least, have been greatly curtailed, and it is doubtful if troops will ever

again be sent to the attack in any other than the thinnest of deployed lines.

The Column: A disposition of troops whose subdivisions are parallel to each other and on the same axis. When they all remain parallel, but upon different axes, they are said to be in *echelon*.

ALLOTMENT OF TROOPS TO SPACE.

Artillery: A battery of six guns, 16 yards from muzzle to muzzle, will occupy 82 yards of space.

Cavalry: Each horse is allowed one yard lateral space—a regiment of 600 in double rank would require 300 yards.

Infantry: Each man occupies two feet of space. In single rank about 2,300 men would occupy a mile of front with intervals between battalions. In double rank and in two lines, allowing for intervals and room for artillery, a division of 9,000 would occupy a mile of level ground.

On the Road: 6,000 infantry in column of fours will occupy one mile of road; 2,000 cavalry in column of fours, well closed, will cover a little more than a mile; 24 guns, with their carriages, one mile, and 100 army wagons, well closed, one mile.

Our army corps of 25,000 men, if posted to receive attack, might have the formation indicated in the accompanying cut. The infantry would be in three

lines—first and second line and reserve—covered by a skirmish line with supports. The divisional artillery would be in front of the first line and opposite the centre and flanks; the corps artillery with the infantry reserve. The cavalry would be in rear of the flanks, accompanied by the horse artillery, the reserve cavalry, in third line.

In posting troops for battle the topographical features of the ground would determine in great measure the position of and the distance between the lines; especially would this be the case with the artillery, which would seek to occupy positions that would give it a cross-fire in front of the infantry. The second line should be near enough to give ready support to the first, but the distance between the lines should be such that artillery projectiles missing the first line would be likely to strike and rise on the rebound before reaching the second.

PLATE I

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Skirmish Line
Battalion deployed



Regt Cavalry - deployed
Col. divisions
Col. of squadrons

Chapter IV.

FREDERICK'S MILITARY SYSTEM.

IN the thousand years following the downfall of the Roman Empire, but little advance was made in the military art, although it was a period of almost incessant war. Moslem and Christian battled for the supremacy in Palestine, in Egypt, in eastern and western Europe. Charlemagne reared a mighty empire by dint of conquest. Yet, when gunpowder appeared, in the fourteenth century, the art of fighting battles was much the same as it had been in the time of Cæsar. The Roman legion seems to have been the model upon which all subsequent commanders based their formations. The sword and shield and defensive armor were still in use, only the slingers and darters of the Roman time had given place to archers and bowmen.

With the advent of gunpowder and the use of portable firearms on the battle field, a change at once became necessary. Formations decreased in depth, the bow gave way to the musket; defensive armor was gradually discarded, and armies became more mobile.

Gustavus Adolphus was the first great commander to appreciate the value of the musket, and to depend upon its fire to win battles. Still, with him, an army was a clumsy machine, slow to move and difficult to take up new formations when once in position.

Marlborough, Turenne and Condé were soldiers of the school of Adolphus. Armies were still unwieldy and battles very ceremonious affairs. Opposing armies came into presence of each other, and, as at Blenheim, deliberately cleared away the ground, took up position, and, when all was ready, the ball opened. Under such conditions, victory usually rested with the side which could longest supply reinforcements to the fighting line.

This was the state of military art when Frederick the Great appeared upon the scene. Armies were yet clumsy; formations still from four to six ranks in depth, and celerity of movement, under existing conditions, impossible.

Frederick's father, "the crazy king," was a born drill master, with a love for soldiers and a passionate fondness for drill. His mania was for drill, to which he devoted the greater part of his time and energy, and was known as "the great drill-sergeant of Europe." When he died in 1740, he left to young Frederick by far the best drilled army in Europe, 80,000 in number, and eight

millions of dollars in the treasury. Under such favorable conditions Frederick came to the throne. His father had kept his soldiers for show, Frederick proposed to put them to use. With this object in view, he set out at once to remedy the defects he had observed in his father's training of the army. The number of ranks was reduced to three; the iron ramrod was introduced; marksmanship was taught, and, above all, he learned his soldiers how to *march*. So well did they learn this lesson that it is said that in marching over the roughest ground, so perfectly could they preserve their intervals, that a simple wheel of subdivisions would form a perfect line of battle.

With such a perfect military instrument ready at his hand, Frederick entered upon his military career. His phenomenal success may be attributed to two causes: *First*, the possession of an army thoroughly well drilled and efficient, capable of rapid movement, and armed with superior weapons; whilst against him were enemies who still adhered to the old formations, and still blindly followed the old tactical traditions. *Second*, the superior mobility of his army enabled him to inaugurate a new method of attack. Instead of following the old way of attacking square in front, he introduced the *oblique order of battle*, or, in other words, turning an enemy's flank. The fact that his enemies always seemed willing to

allow him to take the initiative and always awaited his attack, made this movement all the more feasible, and usually carried with it success.

This manœuvre was executed in this way: His troops were habitually formed in two lines. When he had decided upon the point of attack his troops were put in motion towards the flank selected for assault, usually in column of companies at full distance, in two lines, with a strong advance guard, and with the rear of his columns well refused. Arriving at the extremity of his enemy's line a simple wheel of companies placed him within striking distance in line of battle across their flank, as shown in the cut. (Fig. 1, Plate II.)

Frederick's victories may be said to have been won by his superior *tactics* rather than by his strategy, which was often open to criticism.

Before the old king had been in his grave a year, Frederick found use for his army by the invasion of Silesia, and brought on a war that lasted, with a brief interval of peace, for four years. In this war he was almost uniformly successful; he won the coveted province and learned many valuable military lessons.

In the ten years of peace which followed, Frederick bent all his energies to the perfection of his military machine, and to good purpose, for in 1746 the Seven

PLATE II

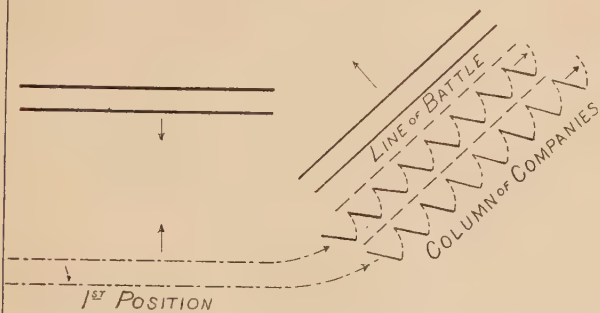


FIG. 1

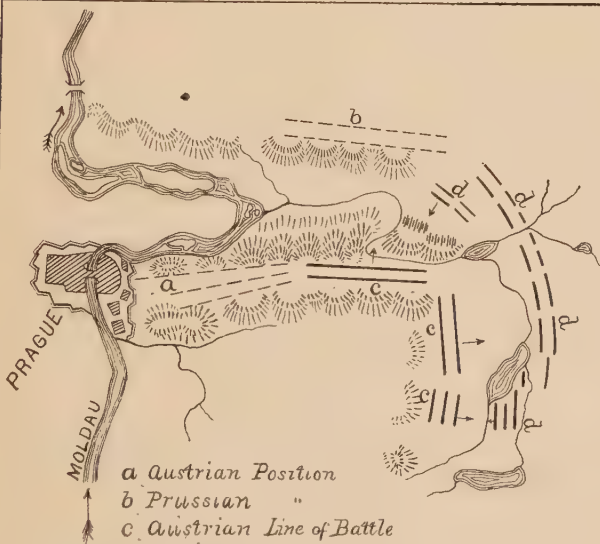


FIG. 2

Years' War broke out, in which he found himself called upon to face the united forces of Austria, Russia, France, Sweden and Saxony. In the second campaign of this war (1757), five hundred thousand men stood in arms, ready to march against Frederick, who could muster barely two hundred thousand to oppose them.

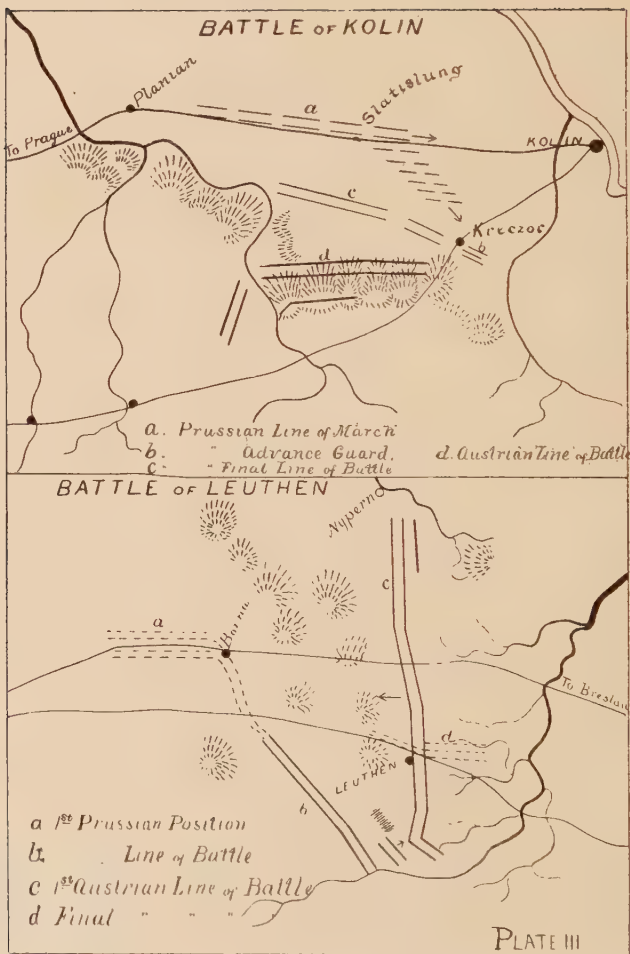
This year, 1757, was for Frederick the most glorious of his military career. In it he fought four pitched battles and won three decisive victories. As they illustrate his peculiar mode of attack, they will be briefly mentioned.

The Battle of Prague, (May 6,) opened the campaign, where Frederick, with 62,000 Prussians, faced an Austrian army of 64,000, under Prince Charles of Lorraine. The opposing forces came into the presence of each other before the city of Prague, both on elevated ground, but separated opposite their centre by a ravine. The Austrian army had one flank secured by the city and fortress of Prague, the other thrown back at a right angle and protected in front by some ponds. Frederick decided upon his favorite manœuvre, and set his troops in motion in two lines of columns of companies toward the refused right wing of his adversary, at the same time sending his cavalry to get in rear of the extreme flank. Forming his line opposite the angle, where,

unfortunately for the Austrians, there was a break in the line, he attacked, separating the two wings driving one from the field and the other into Prague. (Fig. 2, Plate II.)

The Battle of Kolin was fought a month later (June 18), where the odds were 64,000 to 34,000 against him. As at Prague, he set out to place himself across his adversary's flank, moving in column, and preceded by an advance guard. During the movement the main body came in too close proximity to the Austrian line, and was greatly annoyed by their skirmishers. The commander of one of the subdivisions of the leading wing, without orders, halted, faced the enemy and opened fire; those following followed suit; the leading six battalions marched on a hundred yards, when they too halted and opened fire. Frederick's army was thus divided into three parts,—the advance guard forming one. The left wing was driven from the field; the six isolated battalions surrounded and captured, while the advanced guard covered the retreat. Frederick lost 14,000 killed, wounded and prisoners, nearly all of his artillery and many wagons. (Plate III.)

The Battle of Leuthen (Dec. 5) was the most brilliant example of Frederick's flank attack. The odds against him were almost three to one—80,000 to 30,000. The Austrians were commanded by



Prince Charles, the commander who had faced him at Prague, and here, as there, Prince Charles drew up his army in an extended line, one flank covered by a village and the other broken to the rear at an oblique angle and protected by a marsh. Frederick directed his attack in two lines of columns of companies upon the angle, struck the enemy at the selected point and penetrated his line. Reinforcements coming up formed in rear at this point, until the line was here many ranks in depth. The Prussian artillery, taking up position opposite the angle, poured in a murderous fire. The line was again broken. All attempts to reform it failed, and the Austrians were finally driven in rout from the field, with a loss of a third of their army, many guns, colors and baggage wagons. (Plate III.)

Frederick's adversaries were not slow to perceive the advantages of his new mode of attack, and at the battle of Rossbach attempted to turn his own favorite manœuvre against him. This was fought just a month previous to Leuthen (Nov. 5), with odds of 50,000 to 22,000 against the Prussians. Marshal Souboise commanded the allies,—French and Austrians,—and conceived the idea of flanking his enemy out of his position. Unlike his adversary, Frederick did not wait to receive the blow. As soon as the nature of the movement was disclosed, he changed

front, sent his cavalry to his extreme flank, enveloped the head of the long drawn out column of the allies as they approached, beat them in detail, and won a brilliant victory at a loss of less than six hundred men.

The Seven Years' War ended Frederick's active military career, but he lived to see his system adopted by all the military powers of Europe. The evils which naturally follow the carrying to excess of any system, however good it may be, befel this. In attempting to attain perfection in drill, more important things were lost sight of; the element of time was neglected, and, in attempting to provide against flanking movements, lines became dangerously weak and attenuated and offered a tempting mark to the next enterprising commander who should appear upon the scene.

Chapter V.

NAPOLEON'S MILITARY SYSTEM.

AS has been said, Frederick's system was generally adopted throughout Europe, and so continued down to the time of the French Revolution, though the spirit of the system may be said to have died with its author. Perfection in drill, and precision of movement, stiffness and formality, were the characteristics of European armies after the death of Frederick. Added to this, in the endeavor to outflank an adversary, or to guard against being outflanked, lines had become greatly extended—almost pulled apart, so to speak. This latter fact led to a radical change in formations. Up to this time there were no such sub-divisions as brigades, divisions, or corps. The army itself was the integer, and the battalion the chief sub-division. With extended lines it became necessary to divide the responsibilities of command, to break up the line into parts, and the *division* became a recognized sub-division of an army.

Napoleon's military system was the child of the French Revolution. The armies which the young

French Republic summoned to defend itself against combined Europe, were made up of the rawest materials. Poorly clad, poorly fed, and poorly armed, and only half drilled, they possessed a large reserve of enthusiasm and self-reliance.

How to make the most of the material at his hand was the problem presented to Napoleon. To make the most of the enthusiasm, and yet to guard against the lack of cohesion and of discipline, led to the adoption of the distinctive feature of his system. He discarded the line formations, degraded the musket, and threw his men into masses—columns of attack,—depending upon the bayonet and the shock of charging columns. Not only this, he used the three arms systematically,—artillery to shake the nerves of his enemy, infantry in masses to break his line, and cavalry to complete the demoralization.

In his order of battle, the infantry was in column; the artillery of the line in front of the infantry, or opposite the intervals between battalions; the cavalry behind the wings, and the reserve in rear of the center. His reserve artillery, which played an important part, was massed opposite the point selected for attack. His battle tactics may be summarized as follows: The attack opened with the advance of "clouds of skirmishers" and the fire of the *divisional* artillery along the whole line. Behind the cloud of

smoke he massed his charging columns and his *reserve* artillery, with which he opened a furious cannonade upon the selected point—habitually the center. When the artillery had done its work, firing ceased, and out of the screen of smoke emerged his “column of attack.” When the line was broken, a general advance followed, every sabre being sent forward to scatter and demoralize the enemy.

Napoleon’s tactics were *aggressive*, even in defensive campaigns. There is no better example in history of *offensive tactics* in a *defensive campaign* than his defense of Paris after the Leipsic disaster, in 1814.

He habitually aimed to break the center of his adversary’s line, massed his columns there, leaving only a containing force on the wings.

Another feature was that he recognized the mental as well as the physical struggle going on on every battle field, and he always aimed to inspire fear and terror among his adversaries. To this end nothing was omitted; and as a part of the general scheme, we note the half concealed, half exposed formations and manœuvres that preceded the opening of the battle.

Under his system, abnormal extension gave place to *concentration*; line formations and musketry fire, to columns of attack; a large increase in the strength of the artillery and its concentration into heavy masses,

and also the employment of cavalry as a separate corps and in large bodies.

As illustrating Napoleon's way of fighting batteries, *Austerlitz* is a good example. At the opening of the campaign (1805) Napoleon had set out from the camp at Boulogne with an army of 150,000, to make head against two armies, each of 80,000,—one of Austrians, the other of Austrians and Russians. By his superb strategy he captured without a battle, the first army at Ulm; occupied Vienna, and then pushed on after the second army, which had fallen back toward the Russian frontier. Deceiving the Russian commander as to his true situation and intentions, he invited an attack from his antagonist against his own flank; left on that flank barely a containing force; massed a larger part of his army opposite his centre; attacked while the turning movement was in progress; divided the allied armies, virtually destroyed one-half, and drove the other from the field, with an aggregate loss to the allies of 30,000 men, besides artillery and stores.

At *Waterloo* we see him hammering away at the centre of Wellington's line, even to the last charge of the Old Guard, when it would seem, with our later knowledge of the situation, that had the earlier attacks been directed against the English left flank, he would have interposed between them and their

expected reinforcements, and it *might* have won him victory.

At *Wagram*, however, he adopted the turning movement, aiming his blow at the flank of the extended Austrian line; and to insure success and prevent interference with his turning column, he sacrificed Macdonald's corps, with a hundred guns, in a furious assault on the centre.

Like its predecessor, Napoleon's system, or battle tactics, was generally copied by the continental powers, and columns of attack became the favorite formation.

History repeats itself. The genius of Frederick, finding expression through a certain form of military tactics, triumphed over the old order of things. This, in turn, was overthrown by that of the Corsican, who, adopting a system born of *his* genius, raised himself to the dictatorship of Europe.

Both succeeded because each in turn adapted itself to existing conditions, and both failed when adhered to after the conditions which gave them life ceased to exist. The system of Frederick was annihilated at Jena. Fifty years later that of Napoleon led to disaster to the Russians at the Alma, and was finally wiped out in the blood of the French Imperial Guard, at Solferino.

Chapter VI.

MODERN TACTICS.

SINCE THE tactical formations of armies have kept pace with the development of arms, a word with regard to the evolution of the breech-loader may be in order.

Portable fire-arms were first used in battle about the end of the 14th century. The first guns used had a vent on top and were touched off by a companion. The next step was the placing of the vent at the side, with a pan to hold the priming.

The matchlock (1517) was the first serviceable weapon. A curved arm, pivoted on the side, carried a lighted slow-match for igniting the priming.

The wheelock ignited the charge by means of a toothed wheel impinning on a composition of iron and antimony. It was an expensive weapon and its use was confined to pistols and arms used by mounted troops.

The first matchlocks weighed from 15 to 50 lbs., were from 4 to 8 feet in length, and had a calibre of from one-half to one inch. The Spanish reduced its

length, and its weight to 15 pounds, and gave to it the name of musket (1525).

The flintlock was invented in 1630; granulated powder having been introduced a little before. The introduction of iron ramrods and cartridges which followed, made the musket really an efficient weapon.

The English flintlock—"Brown Bess"—which figured in the early Indian wars, the Revolution, the Napoleonic wars and down to 1839, weighed $11\frac{1}{2}$ pounds; 3 feet 6 inches in length; calibre .75 of an inch; bullets 18 to the pound. The French musket weighed two pounds less.

The percussion cap was invented in 1817, by one Shaw, of Bordentown, New Jersey, but did not come into general use until 1840.

Rifled fire-arms were in use in the 18th century, but the difficulty and slowness of loading kept them out of the military service until about 1850-60. In the Crimean war both English and French troops were partially armed with rifles.

Breech-loaders (needle-gun) first appeared in action in Europe in 1850, in the war between Prussia and Denmark, and the result was such that Prussia at once set to work to change her tactics to correspond with the new order of things. In the twenty years following 1850, she devoted her energies to

this task, so that in the war with France she entered upon the campaign with modern arms and modern tactics. In this contest it was needle-gun against Chassepot, and the Chassepot was the better weapon, but the needle-gun with needle-gun tactics was more than a match for the Chassepot with the tactics of the muzzle-loader.

The breech-loader is now rapidly giving place to the repeater, or magazine gun. This is an arm provided with a reserve of from five to eight cartridges carried in a magazine and automatically fed into the barrel of the rifle. There are several methods of attaching this magazine to the rifle; but three, however, are in general use: (1) under the barrel; (2) under the stock; (3) detachable, and secured under the breech just forward of the trigger-guard. In all of these systems but one, the arm can be used as a single-loader, reserving the magazine for emergencies.

The Germans, Austrians, French and Italians have already adopted the repeater. England is about doing so. Our own country seems to be awaiting developments, content with the Springfield, which has fallen far to the rear in the march of improvement.

Nearly all of the modern military rifles are constructed on the breech-bolt system, in which the

bolt, containing the firing pin, moves in a direction parallel to the axis of the bore.

Within the past eighteen months another revolution has taken place in military small-arms. Up to that time a calibre of about .45 in. was considered the best and was universally adopted. Experiment, however, has clearly shown that a calibre of about .30 in. gives greater range, accuracy and penetration, to say nothing of that other advantage which a reduction in calibre affords—the increased number of cartridges which can be carried by the individual soldier. Without doubt the astonishing results obtained by the small-bore rifle is quite as much due to the improvement in the powder as to the mechanical improvements in the piece itself.

Briefly stated, the systems adopted by the leading European countries are:

By Germany—the *Mauser*, with a magazine under the barrel for eight cartridges.

By France—the *Lebel*, which has, like the Mauser, a magazine for eight cartridges. The details of this piece are wanting. It uses a steel-covered bullet and a smokeless and almost noiseless powder; has a calibre of .305 in. and is said to use a bullet *nine* calibres in length.

By Austria—the *Manlicher*, with the magazine for five cartridges, under the barrel and detachable. It

is exclusively a repeater, and can be loaded and fired without removing from the shoulder. It has recently been reduced to .32 in. calibre, and is to use a bullet four calibres in length covered with steel, and so reduced in weight that 146 cartridges of the new equal in weight 100 of the old calibre.

By England—the improved *Lee* will undoubtedly be adopted. It has a calibre of .30 in., with a detachable magazine in front of the trigger-guard; a bullet cased with copper, and, like all the foregoing systems, to use compressed powder.

By Italy—the *Freddi* recoil-rifle will probably be adopted. It is a small-calibred arm, in which the force of recoil is made to open the breech and eject the empty case, obviating all movement of the breech block by hand. Rapid firing is obtained by attaching leather cartridge boxes containing twelve cartridges to the side of the barrel. It can be loaded and fired without removing from the shoulder.

In the *Paulson* recoil-rifle, the gases following explosion enter an aperture in the barrel in front of the chamber, and, by acting on a long, bent rod, force it to the rear, opening the breech-block and compressing a strong spiral spring, which, after the cartridge has been inserted by hand, reacts, when released, to replace the breech-block and rod.

The *Maxim* recoil-rifle is automatic, and constructed upon the same principles as the machine-gun of the same inventor. In it the recoil action of the powder charge is received directly on the breech-block, forcing it to the rear, extracting the empty case and compressing a spiral spring; at the same time a system of levers operates a revolving drum to supply a new cartridge. When the force of recoil is spent, the spring reacts to close the breech and force the cartridge into the chamber. By continuing the pressure on the trigger, the piece will continue to fire until the magazine is exhausted. The magazine contains eight cartridges. The drum is loaded by hand. The breech-block can be operated by hand and the piece used as a single-loader.

The *Hebler*, the invention of a German scientist, reduces the calibre to .296 in., uses a bullet 4.46 calibres in length, with a compressed and perforated charge. The rifling has a twist of one turn in $15\frac{1}{2}$ calibres, or 4.558 in.

The Springfield rifle, with the 500-grain bullet and 100 grains of powder, has an extreme range of 3,500 yards. In the hands of an expert, it has been fired 25 times per minute from the cartridge box, and from 12 to 15 times from the shoulder. In the hands of the ordinary soldier, not more than half this rapidity of fire could probably be attained.

Below is given the details of some of the principal military rifles:

System.	Country.	Weight of rifle.		Calibre.	Weight of cartridge.			Twist in calibres.	Single loader or repeater.	Muzzle velocity, ft. per second.	Maximum range for which sighted.
		lbs.	oz.		Powder, grs	Bullet, grs	Complete				
Mauser.....	Germany..	10	2	.43	77	386	663	1 in 50	sl & r	1410	1570
Lebel.....	France.....	9		.315	..	386	487		sl & r	2034	
Manlicher.....	Austria.....	9	8	.43	77	371	656	1 in 68½	r	1437	1723
Berdan.....	Russia.....	9	4	.42	77	370	610	1 in 50	sl	1444	1165
Remington.....	Spain.....	9		.43	77	386	638	1 in 59	sl	1340	1100
Vitali-Vetterli	Italy.....	9	9	.414	62	312	468	1 in 63½	sl & r	1430	1750
Freddi*	"	7	4	.315	83	225	398		sl	1640	
Martini-Henry	England.....	8	12	.45	85	480	706½	1 in 49	sl	1253	1300
Lee.....	"	9	2½	.303	77	217	437½	1 in 10	sl & r		
Springfield....	United States	9	1.6	.45	70	500	706	1 in 49	sl	1350	1200
Hebler.....	"	9	14½	.296	83	225	521	1 in 15½	sl	1968	2843

*Undergoing trial.

THE PROBLEM OF MODERN TACTICS.

The problem to be solved by modern tactics is how to get men up to within charging distance of the enemy—that is, within 200, or at most, 300 yards.

Under the old conditions of smooth bored guns, where the effective range of the musket was 200 yards; range of field guns 2000 yards, and effective at a third of that distance, there was little difficulty in getting men up to the assaulting point.

The new conditions are: Range of the rifle 2000 yards, deadly at 1000; range of artillery 4000 yards, deadly at 2000. In other words, the "dangerous zone" has increased from 200 up to 2000 yards,

while accuracy and rapidity of fire have increased in the same ratio. How to get men over this 1800 yards of ground is the problem to be solved.

The Germans have offered their "Company Column" as one solution. It is not a system, but simply the means to an end—the end a skirmish line—a skirmish line not to skirmish with but to *fight* with. Briefly stated, the Company Column is thus put into action: A battalion coming to the "dangerous zone" is at once broke into company columns. A German company, at full war strength, numbers 250 men, formed in three ranks. These are divided and subdivided until you get a squad of twelve men. The best shots are in the third rank which is called the "shooting division." Upon an order to deplby, the third rank moves to the front, half the men deploying as skirmishers, the other half acting as a support, 150 yards in rear. The remainder of the company act as a reserve about the same distance in rear of the supports. When necessary the supports move up to the skirmish line, and are replaced by a part of the reserve. In the end the whole company—the whole of the first line—will find itself upon the firing line, and will have been replaced from a battalion in second line. The men gain ground to the front by fits and starts, either in squads, by twos or threes, or singly. In the meantime they put forth every effort

to keep down the fire of the defense, until finally, when enough men have reached within charging distance to make success probable, a rush is made and the line carried, or the attacking party driven back upon its support.

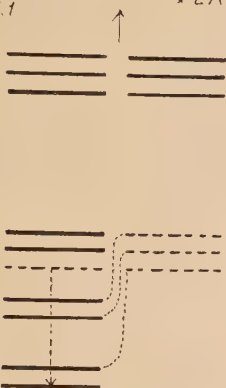
The French Company Column is deployed in much the same way, and is governed by the same general rules as to supports and the working of its way up to the 200 yard limit. French tactics prescribe that when a battalion reaches a point 2000 yards from the enemy's artillery the "order of combat" shall be taken; that is, the battalion is broken into company columns; which is a column of a section, or half platoon front. The squad is always the unit in the skirmish line, and is commanded by a corporal.

Plate IV shows the method of forming company column and how it is afterwards deployed. It is understood that in the recent revision of both the French and German tactics provision is no longer made for throwing the men out as skirmishers with regular intervals; on the contrary, the men are thrown out in groups, with intervals between the groups, with a few scouts or videttes in front of this line of groups. Also that the three rank formation has been abandoned in Germany.

Under the modern condition of warfare, the rule

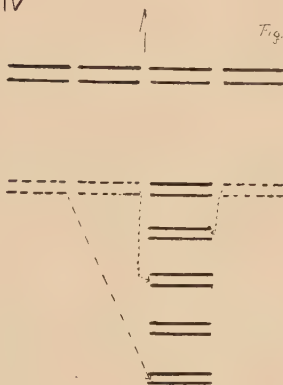
PLATE IV

Fig. 1

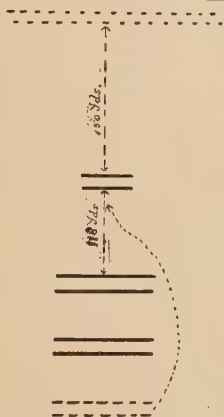


German Company Column

Fig. 2

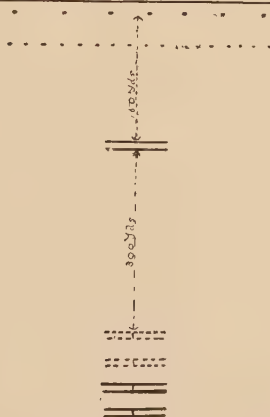


French Company Column



Deployed

Fig. 3



Deployed

Fig. 4

governing any system of tactics is that, except under the most favorable circumstances as to ground and cover, men must, when they reach the "dangerous zone," be sent forward in small bodies, and beyond the 800 or 1000 yard limit, singly, by ones or twos, or by squads. In other words, the skirmisher is the man who must win battles.

But there is another question that confronts the military commander under the modern conditions of warfare; a question that may be said to be the corollary of the main problem. This is how to supply ammunition to the fighting line during a battle. Formerly, with muzzle-loading guns, the forty rounds which the soldier carried upon his person, eked out, maybe, by what he could gather from the boxes of his fallen comrades, was ordinarily an ample supply. Now, with breech-loaders and repeaters, when the volume of fire has increased many fold, when instead of forty, each soldier must have at least eighty rounds immediately available, the question of getting ammunition over the eight hundred or thousand yards of bullet-swept space, between the fighting line and its main support, is a very serious one.

In European services the allowance of ammunition for the individual soldier is usually divided into three lots: 1, That which he carries on his person or is

carried by the company or battalion pack mules or carts, which should be about half of the whole allowance; 2, That which is transported in the division train, and 3, That which goes with the train of the corps, and may be considered as a reserve. Of the whole amount, probably one-fourth would be in the corps ammunition train, leaving three-fourths within reaching distance of the troops engaged.

Many plans have been suggested for getting up ammunition from the second line to the fighting line,—by pack mules, by men specially detailed for the purpose, or, as has recently been proposed, by means of a cart, provided with a bullet-proof shield of steel, which is to be pushed by two strong men. A recent order in the English service provides that in future the amount of small-arm ammunition that shall be taken into the field for infantry shall be 180 rounds per man. Seventy rounds to be carried by the soldier, forty by the regimental wagon or carts, forty in the divisional, and thirty in the corps ammunition column. Communication between the regimental carts and the fighting line is to be kept up during action partly by means of pack mules and partly by men,—a non-commissioned officer and two men selected by the captain, who are provided with bags specially designed for the purpose, each to weigh, when filled, not more than forty pounds.

The English have proposed an ammunition cart capable of transporting as many as 20,000 rounds, depending on the nature of the ground. In shape it is like the bow of a boat, turned upside down, and mounted on wheels. The material is of steel, three-sixteenths of an inch in thickness, and it is estimated that it will turn bullets anywhere beyond five hundred yards range. The cart is propelled by two men walking behind it, who are, of course, covered.

The amount of ammunition to be carried into the field, in different European armies, does not seem to have been definitely fixed. The whole question of ammunition supply — the number of rounds to be provided, as well as the means of getting it up to the fighting line, is in a transition state. With the adoption of the small calibre rifle the figures given below will be considerably increased. In the English service it is proposed to increase the number of rounds to be carried by the soldier from seventy to one hundred and fifteen. In France the whole amount of available ammunition is proposed to be increased from 174 to 250 rounds.

The figures below are given with some reserve, but are believed to be correct, as far as at present decided upon:

AMMUNITION SUPPLY.

	<i>France.</i>	<i>Germany.</i>	<i>Austria.</i>	<i>Italy.</i>	<i>Russia.</i>	<i>England.</i>
By the soldier.....	78	100	100	88	84	70
By pack mules, carts, regimental or battal- ion wagons, and at once available. }	96	32				40
By division train, and available in prolonged action. }		65	134	83	124	40
By corps trains*.....						30
Total Supply.....	174	197	234	171	208	180

* Details are wanting.

Chapter VII.

STRATEGY.

STRATEGY is the planning of a campaign and the determining of the character, direction, and the object to be attained by military operations, and embraces all operations prior to actual tactical collision. "A strategist moves the corps, divisions and brigades of his army as a chess-player moves his pieces, namely to deceive his adversary and conceal his own purposes until within practicable limits of its sure accomplishment. He never shows his hand, even to his friends. Strategy is the mutual struggle between the leaders of hostile armies. It is a kind of lying by means of object-lessons; a thimble-rigger's game, in which the dupe is never so sure to be wrong as when he is sure he is right."

The methods employed in organizing armies, and the tactics by which their movements are regulated, have undergone many changes since men were first assembled in organized bodies for warlike purposes, but the principles of strategy have undergone no

such change, since they are independent both of the nature of the arms and the organization of the troops.

Strategy is a much more difficult science than tactics. Every war developes good tacticians, but the masters of strategy are rare indeed.

All strategical operations may be said to have for their object one of three things : First, To menace or assail an enemy's communications with his base.

Second, To destroy the coherence and connected action of his army by cutting communications between parts of his front.

Third, To effect superior concentrations on particular points.

The operations of strategy must not be confounded with tactical operations of the same nature. To out-flank an enemy on the field of battle; to break his line, or to overwhelm it at a single point, would come under the head of Grand Tactics. Battles belong to the domain of Grand Tactics. They are simply incidents to a campaign, which may be won by strategy without firing a hostile shot.

The preliminaries to a campaign, which determine the character of a campaign, whether offensive or defensive, its direction and object, and the means to be used for carrying it on, are

usually decided upon by the statesman and not by the soldier. From a military point of view this is unfortunate. The best results may be expected where the military commander is himself the chief of the state. It is safe to say that neither Caesar, Frederick nor Napoleon could have accomplished what they did had they been hampered by Parliaments or Legislative Chambers. War is despotic; an army is a despotism, and a monarch who is himself a soldier, and commands his own troops, has more than double chances of success.

In planning a campaign, the first thing to be determined is whether it shall be *offensive* or *defensive*. The reasons that may determine this point are not necessarily all military; they may be political or geographical. Political and aggressive if the war were one for the acquisition of territory or to re-establish control over a revolted province. Geographical and offensive if an enemy's frontier were open and poorly guarded by natural obstacles, and the lines of advance were direct. The military reasons for taking the offensive would be, if you were ready and your enemy were not; if your army was numerically superior and your lines of advance and bases were reasonably secure.

On the other hand, an army would take the defensive for political reasons if it were a question of main-

taining possession of disputed territory; for military reasons, if it were inferior in numbers, or the lines of his approach long and easily assailed. The geographical reasons would be a frontier with strong natural obstacles, as a range of mountains or a deep river.

In the war of the Rebellion there were military, political and geographical reasons why the North should take the offensive, and reasons equally strong why the Confederates should choose defensive campaigns.

The advantages of the offensive in a campaign are that the commander of the invading army knows exactly what he wants to do; his object is plainly before him, and all the means for the accomplishment of his purpose have been carefully thought out, together with the methods for foiling the probable counter-movements of the enemy. Another great advantage is the power of concentration, keeping all of one's forces together and striking a decisive blow at the outset of the campaign.

On the other hand, the commander acting on the defensive is in ignorance as to where the blow will fall, and must consequently scatter his forces to watch all the probable avenues of approach; he is obliged to follow the lead of his adversary and parry his blows instead of assailing him. He has, how-

ever, the great advantage of operating on interior lines; of being able to concentrate quickly upon a threatened point; of being among friends, and, if beaten, can fall back upon his own depots and supplies.

The object of a campaign, next to beating an enemy's army in the field, will naturally be the capital of his country, since nothing is so disheartening and humiliating to a people as the capture of their seat of government.

The line of operations will be determined by the character of the troops to be employed, the nature of the frontier, and the presence or absence of railroads, rivers, and roads for supplying the invading army.

The character of the troops to be employed will influence the selection in that if the invader has an efficient cavalry force he will seek an open country where it can be manœuvred; if strong in artillery, good roads are necessary, while if the main dependence is on his infantry a broken country might well be selected.

Strategical Operations of the 1st Order:
To menace or assail an enemy's communications with his base.

In the Atlanta campaign, 1864, the operations were of this order. General Sherman with an army of a hundred thousand men, opened the campaign

early in May. His base of supplies was Nashville, 136 miles in his rear; his starting point, Chattanooga. His objective was the Confederate army under Johnson, numbering a little more than half his own force. The Confederates were in strong position in front of Dalton, with their line of retreat along the railroad running to Atlanta, through a mountainous country which afforded many naturally strong positions for defense. General Sherman, with his greatly superior numbers, could leave a force to guard his own, while moving against the Confederate line of supply. By threatening their communications, and much severe fighting, he compelled the successive evacuation of Dalton, Resaca, Kingston, Kenesaw Mountain, the line of the Chattahoochee and finally Atlanta. (Plate V.)

In the Marengo campaign, 1800, Napoleon, by deceiving the Austrian commander as to his line of advance, succeeded in throwing his army squarely across the enemy's line of communication. He was numerically inferior to his antagonist, and the movement was extremely hazardous, and nothing but the best generalship saved him from destruction.

This movement is always attended with great risk, since the army undertaking it has to expose its own communications. Superiority in numbers or favorable topographic features alone warrant it.



Of the 2d Order: To divide an enemy's front.

General Sherman's march to the sea is an example on a grand scale, of the second order of strategical operations. Turning northward after reaching the coast, he compelled the evacuation of Charleston and brought to the assistance of Grant in Virginia his army of 60,000 men.

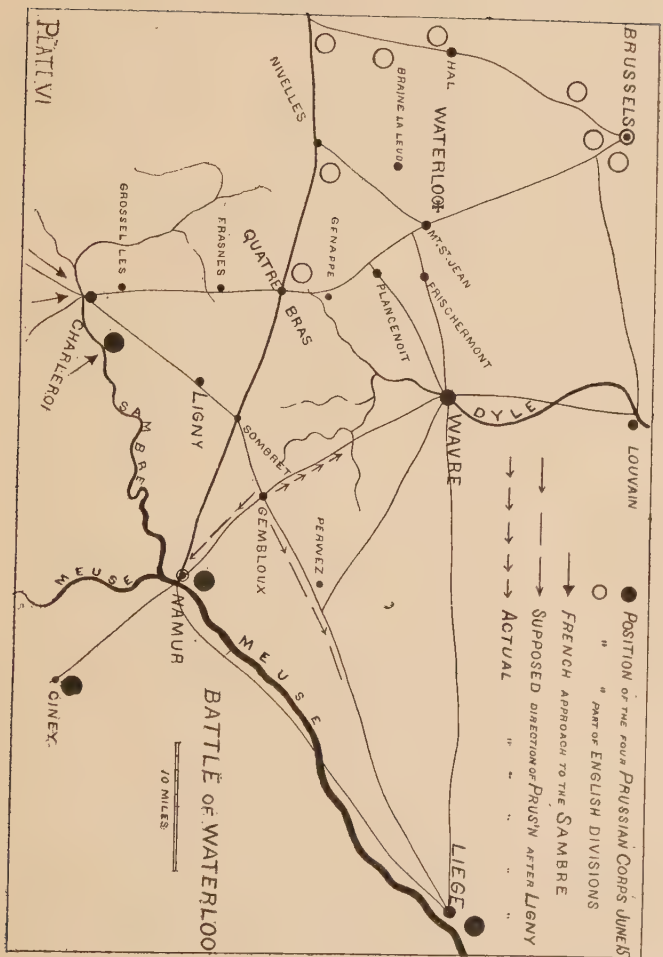
Napoleon's method of solving this problem was as follows: Dividing his army into three grand divisions—right, left and centre—he assembled it opposite the point to be assailed. Breaking through, he joined his centre to one of his wings and assailed one-half of the divided enemy; withdrawing his centre, he joined it to the other wing and fell upon the other half.

The Waterloo campaign, 1815, is another example. Napoleon, with an army of 125,000 moved against more than 200,000 Prussians and English-Belgians, extended on a line of a hundred miles. His object was to separate the Prussians from their English allies and then beat them in detail. He struck their line near its centre at Ligny, completely severing the lateral communications; attacked and finally defeated the Prussians with his right wing and centre; sending Grouchy with the right to follow the retreating Prussians, he joined Ney with his centre at Quatre-

Bras to destroy Wellington. The first step was a success, but the campaign was a failure. The reasons therefor are not far to seek, and may be summarized as follows: (1) In making his first attack with inadequate numbers; (2) In supposing the Prussian army routed when it was not badly beaten; (3) His ignorance of the direction of their retreat and of the existence of a practicable road across the river Dyle, at Wavre, by which they could join Wellington. (Plate VI.)

Of the 3d Order : To effect superior concentrations on particular points.

The campaign of 1814, in Champagne, is an example. After the disaster at Leipsic, Napoleon, retreating before the victorious allies, prepared to dispute their advance on Paris, with an army of less than 100,000 men, opposed to more than twice that number. Fortunately, for him, the allied army was divided, one column coming from the east, another from the northeast and a third from the north. His first contact was with the southern column, in which he was worsted. Taking his entire force, except two divisions, he fell upon the centre column and routed it completely. Returning to the southern column, he attacked and drove it back toward the frontier. In the meantime the third column had joined the second. Again leaving a small force to



watch the southern column, he moved with his entire army against the two combined columns of the allies. He gained decided advantages at first, but was finally beaten and pushed aside and the allies moved at once on Paris. The campaign, which opened on the 25th of January, was closed by his abdication on 6th of April. .

In strategy the campaign was good, the fighting superb, but it failed because the French were simply overborne by sheer force of numbers.

Chapter VIII.

MILITARY OBSTACLES.

A MILITARY obstacle is any *surmountable* impediment to military operations an enemy's country may present. It may be either natural, as a mountain range, a river, or a swamp; or artificial, as a fortress.

The presence of obstacles influence both the direction of operations and the character of the troops to be employed in a campaign.

An impassable mountain is not a military obstacle, properly speaking, since strategy is wholly debarred by the conditions.

Rivers and mountains, passable only at certain points, are identical in their influence on military operations, since both bring together at certain points the roads and highways of commerce and civilization.

A river is a less complete obstacle than a mountain range. It is harder to defend; the crossings are usually more numerous and the lateral communications along the banks better.

A mountain chain which affords but one point of passage can give no opportunity for the exercise of strategy for the assailant, but may for the assailed. If passable at several points it affords a capital strategical problem.

The efficiency of a river as an obstacle depends upon its width and depth; upon the character of its banks—whether higher upon one side than the other—as well as upon whether it is straight or crooked.

In Italy, north of the Po, the obstacles are rivers; south of that stream, mountain ranges. Spain, with its network of mountains, has always been a difficult theatre for military operations. A glance at the map will show, in a measure, why the French army made so little headway there during the Napoleonic wars.

In the United States the obstacles are both rivers and mountains. The Alleghenies, extending from Pennsylvania to the northern boundary of Alabama, intersect the eastern half of the continent, pouring streams both right and left into the Atlantic and the Mississippi, played an important part in the military operations of the rebellion.

This mountain barrier separated completely the armies of the East and the West. Blotting it from the map and the Army of the Potomac and those of the Ohio, the Tennessee and the Cumberland could

often have co-operated. But as it was, Sherman or Grant or Buel, or any of the western commanders, were completely isolated from the troops serving in Virginia.

The passage of any river, almost, may be forced even in the presence of an enemy. This may be done either by a pontoon or a "flying bridge." A pontoon bridge is a bridge of boats, sufficiently stable to bear artillery and trains. The boats are flat-bottomed, connected together by stringers, upon which the roadway is laid. These boats are transported on wagons constructed for the purpose, and which form a special train under charge of the engineers. A "flying-bridge," properly speaking, is a boat or raft anchored up stream by a cable, and plying from shore to shore. Ordinarily the term is used for any temporary contrivance for crossing a stream—a boat, a raft, or a bridge of boats built up stream and floated down to the point of crossing.

History affords many brilliant examples of forcing rivers in presence of an enemy. Napoleon's passage of the Danube, just before the battle of Essling, in the presence of a powerful foe, and repeating it, six weeks later, previous to Wagram, are well known examples.

At Chattanooga, or in his preparations for the attack on Missionary Ridge, it became necessary for

General Grant to effect a lodgement on the Confederate bank of the Tennessee, which was strongly guarded. For this purpose something over a hundred boats were quietly constructed in a little stream that emptied into the Tennessee above the town, and on a dark night—the one preceding the day selected for the assault—each boat, manned by thirty well-armed men, floated down the stream to the point selected for crossing, the boats were run ashore on the Confederate side, the men leaped out, and at once began to intrench themselves. As soon as the men were ashore the boats returned to the northern bank, where General Sherman's command was waiting, and before daylight two whole divisions were over and the lodgement secured against assault.

A fortress, when in the path of an invading army, must either be captured, turned or masked. It would be turned if the army avoided it entirely by taking a different route; masked, if a sufficient force were left to watch it while the main body pursued its march. If too strong for open assault its capture would involve regular siege operations.

Chapter IX.

EXPLOSIVES.

Explosives in general are bodies so constituted that, by disturbing the chemical equilibrium of their ingredients, usually by heat, are converted instantaneously from a solid or liquid form into gases of high temperature and tension. The shorter the time occupied by the explosion, the greater the heat and consequent expansion of the gases.

An explosive body must be so constituted that it will, on explosion, form large quantities of permanent gas. Almost without exception, explosives are composed of carbon, oxygen and nitrogen. When explosion takes place, the carbon and oxygen unite to form carbonic acid gas, and nitrogen is set free. Carbon and oxygen readily combine, and the combination is accompanied with great evolution of heat. The nitrogen in the compound is in combination with oxygen; but its attraction for the latter is feeble, and it readily gives up its oxygen to the carbon, taking itself the gaseous state.

Explosives are divided into two general classes — (1) *mechanical mixtures*, and (2) *chemical compounds*.

First Class : The ingredients are mechanically mixed, and can be separated by mechanical means, and explosion is by combustion of the individual grains, progressively. (Gunpowder).

Second Class : The elements composing it are in chemical combination, and cannot be separated except by chemical change. Explosion is not by combustion; all parts decompose simultaneously, and the initial pressure is the maximum one. All the high explosives are of this class.

GUNPOWDER.

Who discovered and who first used it as a projectile force has always been a disputed point. The honor is claimed both for the Chinese and the Arabs. The truth seems to be that the Chinese were the first people to use a compound containing saltpeter, sulphur and charcoal, but purely as a pyrotechnical preparation. In the intercourse between the two countries, a knowledge of this mixture was carried to Arabia, where it was developed into practical use as a projectile force, and appeared on the battle field in China, by the Mongols, in 1234 A. D., at the siege of Tsai-Chew. Nevertheless, there seems no doubt but that the real discoverer of the explosive properties of nitre, sulphur and carbon, so far as concerns its use in European countries, was a German

monk, one Berthold Schwartz, and that its discovery was purely accidental.

It is a singular fact that after 500 years the ingredients of gunpowder are the same, and their proportions almost identical with the mixture used in the first fire-arms. The improvements have been almost entirely in the purification and manner of manipulating these ingredients—especially as to the form and character of the grains. From mealed powder, in which form it was first used, down to the hard, brown prisms, weighing from an ounce to half a pound, we have a complete history of the growth of this explosive.

Gunpowder is a mechanical mixture of sulphur, nitre and charcoal, usually in the following proportions, by weight: Nitre, 76; sulphur, 10; charcoal, 14.

Without going into the details of the manufacture of gunpowder, it may be said that the operations of its fabrication are seven in number: (1) pulverizing; (2) incorporating; (3) compressing; (4) granulating; (5) glazing; (6) drying and (7) dusting. The ingredients are first pulverized separately in cast iron barrels; then mixed in proper proportions by weight and thoroughly incorporated by means of heavy cylinders made to roll around a horizontal axis in a circular trough; it is then sprinkled with water and

subjected to a powerful pressure until it is reduced to a solid cake; the cake is broken into fragments or grains by passing it between iron toothed rollers until reduced to the proper fineness. To render it less liable to absorb moisture it is glazed by revolving in a leather barrel, the grains polishing each other by attrition. Drying and dusting complete the process.

The size of grain exercises an important influence upon the pressure exerted by a charge of fired gunpowder. The smaller the grain, short of mealed powder, the quicker the combustion and consequently the greater the pressure. The grain of cannon powder, used in field guns, is about .1, that of mammoth about .9 of an inch. Gunpowder should have a specific gravity of not less than 1.75. It explodes at 572 degrees F.

All recent forms of powder for heavy guns have special shapes, and, as with the German cocoa, or slow burning powder, a special process of manufacture. These forms are spherical, sphero-hexagonal, hexagonal and prismatic. The larger forms are perforated so as to burn upon an increasing surface. Recent improvements have been in the direction of "slow-burning" powder. With this the force on the projectile is exerted more like a *push* than a blow.

The combustion of a grain of gunpowder is progressive. With ordinary form of grain, the greater part of the gas is evolved in the first two-tenths of the time.

The chemical equation for the reaction of fired gunpowder as usually given is $2\text{KNO}_3 + 3\text{C} + \text{S} = \text{K}_2\text{S} + \text{N}_2 + 3\text{CO}_2$. This equation is not really correct, for besides sulphide there is also potassic sulphate, carbonate and hypophosphite (solids), sulphuretted hydrogen, marsh gas, etc.

Many eminent chemical experimenters have claimed that no general chemical expression for the products of exploded gunpowder can be given, and that all attempts to reduce to a formula the chemical reactions that occur during gunpowder explosion are misleading and valueless. On the other hand, it is claimed that given pure ingredients of known strength, especially the charcoal, a reliable equation can be obtained which will represent all the products, both solid and gaseous, resulting from burning a given charge of gunpowder.

Under any circumstances, gunpowder is a wasteful compound. The amount that is unconsumed or remains in a solid state is always large. The experiments of Bunsen and Schischkoff go to show that the waste in gunpowder is about 68 per cent. of its own weight, only about 32 per cent. being utilized. That

is to say, that only about one-third of a charge of gunpowder appears after explosion in the form of permanent gases.

THE HIGH EXPLOSIVES.

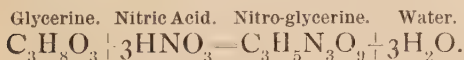
All the high explosives are *chemical* compounds, and owe their explosive force to the action of nitric acid upon cellulose, wood fibre, glycerine, etc. Each is formed by introducing into a body composed of oxygen, carbon and hydrogen, nitrogen and oxygen in feeble combination, in place of part of the original hydrogen. A new substance is obtained, unstable from its greater complexity, and also from the peculiar condition of the added atoms. The nitrogen holds the oxygen so feebly that a slight disturbance of the equilibrium brings into action the stronger attractions of the carbon and hydrogen for oxygen.

The number of explosive mixtures is very large, and the number is being added to constantly. Of those that have been tested by actual use, we have gun-cotton, nitro glycerine, the dynamites, explosive gelatine and rackarock.

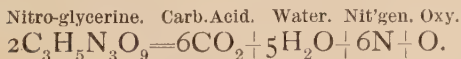
Gun-Cotton was the first invented (1846), and is simply clean cotton subjected to the action of a mixture of nitric and sulphuric acid. The sulphuric acid does not enter into combination; it acts simply as a carrying agent, taking up the water, and preventing the nitric acid from destroying the fibre of the cot-

ton. It has twice the projectile, and four times the explosive force of gunpowder. It explodes at 360 degrees F.

Nitro-glycerine, or blasting-oil, as it was at first called, is formed by the action of a mixture of nitric and sulphuric acid upon pure glycerine at a low temperature. As in the case of gun-cotton, the sulphuric acid does not enter into combination. It is an oily, colorless liquid, very slightly yellow, of sweetish taste, and with a specific gravity of 1.6. Its firing point is about 365 degrees F. It is not affected by water; freezes at 40 degrees F., and is comparatively safe when frozen. It has about ten times the explosive force of gunpowder. In its manufacture the reaction may be represented by the equation—



When exploded, the reaction may be expressed by the equation —



Comparing this equation with the one given for the reaction in the case of gunpowder, and remembering that in this case the decomposition is instantaneous, it can be readily seen why the high explosives act so much more powerfully than does gunpowder.

It was found that liquid explosives, like nitro-glycerine, except in a frozen state, were dangerous to store or transport, while solid explosives were less dangerous. This led to the invention of dynamite, which is simply nitro-glycerine mixed with some inert absorbent, and thereby converted into a solid body.

The Dynamites, of which there is a large variety, are divided into two very distinct classes, namely, those which contain a chemically *inactive* absorbent, as dynamite No. 1, and those which contain chemically *active* absorbents, as Dynamite Nos. 2 and 3, Atlas Powder, Lithofracture, etc.

Dynamite No. 1 consists of 75 per cent. of pure nitro-glycerine and 25 per cent. of infusorial earth, or *Kieselguhr*. In this case the absorbent exerts no chemical action whatever on the explosion, and remains behind as an unaltered residue. In appearance it is a loose, soft, readily-moulded substance of buff color. It freezes at 40 degrees F.

In the second class of dynamites, and all the other nitro-glycerine mixtures, the absorbent is itself an explosive, as the nitrates of potassium and sodium, resin, wood fibre, etc.

Under this class comes the most powerful, and, it is believed, the best of all the high explosives — explosive gelatine, or gum-dynamite.

Explosive Gelatine is made by dissolving in 90 parts of nitro-glycerine, 10 parts of collodion gun-cotton. The mixture gelatinizes into a solid state. In appearance it is a gelatinous, elastic, pale yellow substance, with a specific gravity of 1.6. It can be cut with a knife, rolled into strips and formed into any required shape. It is not affected by water, and does not require any particular care in its handling or transportation. By the addition of 4 per cent. of camphor, it becomes, for all practical purposes, inert and harmless. Under these conditions only a powerful primer will explode it. Rifle bullets fired into it at short range will not. It is believed to possess both mechanical and chemical stability, and, by mixing camphor with it, its insensibility may be augmented at will. As shown below, its explosive power is greater than that of either of its constituents.

The relative force of the various high explosives is differently given by different authorities; that of Nobel's Explosive Company, of Glasgow, is as follows, taking blasting-gelatine as 100, and comparing them, weight for weight:

Nitro-gelatine.	100.00
Nitro-glycerine	93.36
Dynamite No. 1.	75.11
Lithofracture	65.59
Gun-cotton	65.43
Dynamite No. 2.	51.23

Gen. Abbott, in his report on explosives, places them as follows, when fired under water (Dynamite No. 1 being taken as the standard):

Dynamite No. 1.....	100
Gun cotton.....	87
Nitro-glycerine	81
Rackarock	86
Explosive Gelatine.....	117

Gun-cotton, dynamite, and nearly all the high explosives, when ignited in small quantities, burn slowly without explosion. If sufficient quantity be fired, explosion takes place. But to obtain the full effect of any of these mixtures, a detonating cap or primer is necessary; in other words, the force exerted depends very much upon the character of the initial impulse that upsets the equilibrium of the atoms. Fulminating mercury has been found to be best adapted for this purpose.

Besides the explosives already mentioned, a number of others have recently appeared, which promise to take a permanent place in the list. Among them we have

Carbo-dynamite. To obviate the objections to ordinary dynamite—the separation of the glycerine from the absorbent; its disagreeable and dangerous fumes, and the character of the gases given off by explosion—the inventor of this explosive substitutes,

for the inert absorbent; 10 per cent. of carbon, which is both an inflammable body and a safe and healthy absorbent. The gases given off are innoxious, and an explosive effect of 50 to 75 per cent. greater than dynamite is claimed for it.

Roburite. A German invention. Consists of two non-explosive and perfectly harmless substances, which may be stored with safety. When mixed, they become roburite. Intense heat is necessary to explode it. The explosive force claimed for it is 25 per cent. greater than dynamite No. 1.

Melinite, the invention of two captains of the French army, made its appearance two years since, and was heralded as the most powerful explosive known. It is said to have been given its name because in color it resembles honey (*miel*). The ingredients, as well as the mode of manufacture, have been kept a profound secret, but it is believed to be a mixture of fuzed picric acid with tri-nitro-cellulose, dissolved in ether. Its inventors claimed for it one hundred times the power of gunpowder and ten times that of nitro glycerine. The French were pushing its manufacture with great energy when, in March of last year, a shell in one of the workshops at Belfort exploded of itself (afterwards claimed from chemical action set up in the compound), killing and wounding seventeen out of twenty-five men in the building.

This put an end for the time to its use, but laterally its manufacture has been resumed. Recent experiments with it in shells seem to indicate that it possesses an explosive force about equal to that of nitroglycerine.

Bellite. Benzine treated with a mixture of sulphuric and nitric acids, is converted into trinitrobenzine. It is then mixed with nitrate of ammonia in the proportions of four of the latter to one of the former, and becomes bellite. It is said to be very stable, and recent tests, both by heat and shock, seem to have fully confirmed all that is claimed for it in this regard. A strength thirty-five times greater than gunpowder is claimed for it; and for detaching rock, is said to possess greater efficiency than any of the nitro glycerine compounds.

Emmenseite takes its name from its inventor. Like Roburite and rackarock, it is composed of two ingredients,—one a new nitro derivative of certain hydrocarbons of the aromatic series; the other a mineral salt. The exact character of the ingredients and method of mixing are the features of the invention. It is said that it can be fused and cast into any desired form, and by granulating, a powder of any desired quickness of action obtained. Taking for granted all that its friends claim for it, it enjoys the distinction of being the only high explosive that can

be used in firearms. They claim for it an explosive power considerably greater than nitro-glycerine and double that of dynamite.

Securite,—a German invention. Said to be flameless when exploded, and of particular service in engineering work where fire-damp exists. It is composed of nitrated hydrocarbons mixed with an oxidizing agent, as chlorate of potash, and some organic salt, which renders the mixture flameless.

Hellhoffite is one of the latest additions to the list of explosives. It is liquid, and is formed by a combination of the nitro products of tar oils with nitric acid. Its special value is claimed to be in mining,—and an explosive force 70 per cent. greater than dynamite and 30 per cent. than nitro-glycerine.

It should be stated that the results claimed to have been obtained from all the later additions to the list of high explosives, are given with reservation. It is not known that any of them have been thoroughly tested by competent, unprejudiced parties.

In conclusion it may be said that the two classes of explosives have each a distinctive value, aside from their use in a purely military way. Gunpowder does its work progressively and may be called a *disintegrating* compound. It is a good agent for rending apart rock, but not a good one for breaking it up.

Its action is always in the direction of least resistance. On the other hand, the dynamites may be called *shattering compounds*; their explosion is practically instantaneous, and the force developed exerted equally in all directions. They are wholly unfitted for use as a projectile-force in fire-arms.

Chapter X.

CANNON.

FIRE-ARMS are divided into two general classes: cannon and small arms.

The first cannon was a mortar, firing stone balls, with a charge of mealed powder equal one-half the weight of the projectile.

The Bombard came next, built up of wrought-iron staves, strongly hooped, a conical bore, and fastened to a block of wood.

The Culverin, of bronze, of great length, using iron balls and granulated powder, was the first really serviceable cannon.

Shell, or bombs, as they were called, were first used in mortars. Until the invention of the *sabot* (a block of wood fastened to the rear of a projectile) the artilleryman of those days saw no way of using these projectiles in guns for horizontal fire except by making the piece short enough so that he could place the bomb in the bore with his hands, with fuse in proper position. These short pieces are called *howitzers*. The

name is still retained for comparatively short and light pieces, of large bore, intended only to throw hollow projectiles.

The improvement in cannon kept pace with that of small arms. Rifled cannon came into use but little later than the rifle-musket, but it has taken much longer for the rifle to assert its superiority with heavy than it did with field guns or small-arms.

The metals used in the construction of cannon are bronze, wrought-iron, steel and cast-iron.

Bronze is composed of 90 parts of copper and 10 of tin. It has a tensile strength of about 40,000 lbs. per square inch, and will stretch from 5 to 10 per cent. before breaking. It lacks sufficient hardness for rifled guns, and is expensive.

Aluminium-bronze has recently been experimented with, and owing to its lightness and strength, promises to occupy a prominent place among the gun metals of the future.

Wrought iron is pure iron. It has a tensile strength of about 60,000 lbs. per square inch, and will stretch 10 per cent. before rupture. The difficulty of welding it in large masses is its chief defect as a gun metal.

Steel. By adding from .25 to 1.75 per cent. of carbon to wrought, or pure iron, it becomes harder,

and capable of taking a "temper." The carbon enters into the chemical structure of the metal; it becomes elastic, stronger, and capable of resisting strains of all kinds to a much greater degree than did the wrought-iron alone. It has a tensile strength of from 50 to 150 thousand pounds per square inch. When thoroughly worked by the rolls or under the hammer Bessemer or Siemens steel should possess a tenacity of 70,000 lbs. per square inch, and a ductility of 20 to 25 per cent.

Cast Iron. By increasing the amount of carbon added to wrought iron, it reaches a degree of hardness when it cannot be wrought, and passes from steel into cast iron. Iron with from 1.75 to 2.5 per cent. of carbon, becomes hard and brittle. The carbon in this case is in the physical structure of the metal, and takes from instead of adding to its strength. It will stretch only about 1 per cent. Gun metal iron should have a tensile strength of from 35 to 40 thousand pounds per square inch.

CONSTRUCTION OF CANNON.

All the earlier cannon were cast, and of iron or bronze. "Built-up" guns were first constructed in England about 1859. This method is now almost universally employed. The principal systems of gun-construction are

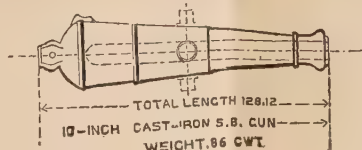
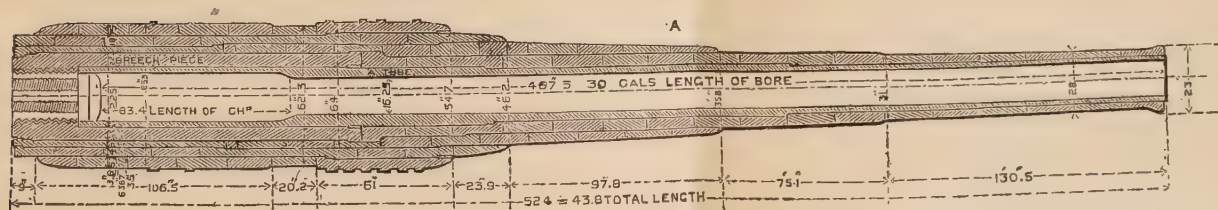
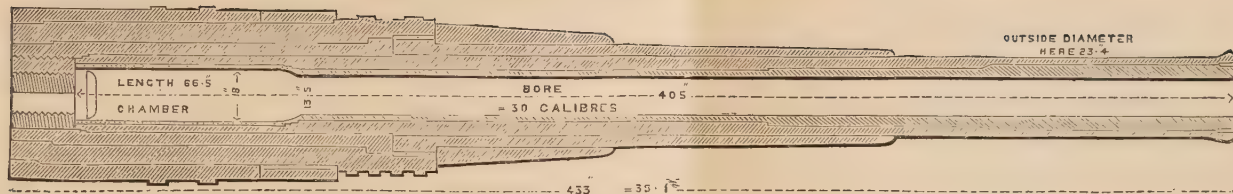
In England,—the *Woolwich*, *Armstrong* and *Whitworth*. The first the government, the latter private firms. The first two systems are essentially the same:—an inner tube of solid steel, reinforced with wrought iron coils, steel cylinders or rings, shrunk on by heat. In the Whitworth system the material used is wholly fluid-compressed steel—the metal being subjected to great pressure while in a semi-fluid state. The inner tube is slightly conical, over which is forced the outer rings or jackets by hydraulic process—one over the other.

In the *Krupp* (German) system, the guns are constructed throughout of crucible steel, run into ingots of suitable size, and then forged under powerful steam hammers. The inner tube is made of a solid block, cylindrical about the base and conical toward the muzzle; a steel sleeve, containing the breech-block aperture, is first placed upon the tube, and over this sleeve are placed the bands made from solid disks of hammered cast steel, shrunk on by heat.

The accompanying cuts of the 67 and 111-ton English guns will show the general method of construction of built-up guns. The number of coils or rings shrunk over the inner steel tube depends, of course, upon the size of the piece. (Plate VII).

In the United States the system now in vogue is to purchase the steel forgings for the inner tubes, jack-

OUTSIDE DIAMETER
HERE 57



ets, etc., of private manufacturers in the rough, and afterward assemble and finish in Government shops. The forgings for our first built-up guns were procured abroad, of Whitworth, but now reliance is placed wholly upon steel of American production. 6, 8 and 10-inch steel breech-loading rifles have been constructed at the Washington Navy Yard, for the Navy, which have, upon trial, given very satisfactory results. An 8-inch rifle for the Army, of the same general pattern, has recently been assembled at the West Point Foundry, and the ballistic tests of this piece are said to exceed the published results of any other gun of its calibre in existence.

The length of bore of a cannon should be such as to hold the projectile until the entire charge is converted into gas. With smooth-bore guns this is about 16 calibres,—with modern rifled guns, using heavy charges of slow-burning powder, the length is from 30 to 40 calibres.

The principal strains to which the metal of a gun is subjected are (1) the *tangential*, the force acting directly outwards and such as would tend to burst the hoops of a barrel; (2) *transverse*, such as would bend outward the staves of a barrel, and (3) *longitudinal*, the force that tends to pull the gun apart in the direction of its length, and is maximum at the bottom of the bore and zero at the muzzle.

The calibre of a gun is the diameter of the bore expressed in inches or centimetres. In the United States and all European countries, except England, guns are designated by their calibre; in England by their weight in tons. Formerly the weight of a spherical ball was used to designate calibre; 6, 12, 24, 32, and 64 pounders, were the guns in use in the United States up to the time of the Rebellion.

During and since the Rebellion the United States has fabricated smooth-bore cast-iron guns in great variety and in large numbers,—15 and 20-inch guns leading the list. The ballistic capabilities of this system of guns have never been exceeded by any smooth bore guns ever made, but in the modern game of war the smooth-bore cannon is quite as antiquated as the smooth-bore musket of forty years ago.

MODERN ARTILLERY.

Artillery in general is divided into three classes—*Field*, *Siege* and *Sea-coast*. The first must possess sufficient mobility to accompany troops in the field; the second be of a weight that will admit of their being transported over ordinary roads, while the last class embraces all heavy guns intended for the defence of sea-coasts and harbors. In addition to guns proper, there are mortars belonging to each of the

three classes — a mortar being a short piece using a small charge of powder, and intended for vertical fire only.

All modern guns are rifled, and, almost without exception, breech-loaders. Steel, either wholly or in part, is to-day the universal cannon metal of the world.

Rifles and Rifling. The object of rifling a fire-arm is two fold: *first*, to obtain for a given diameter of projectile the maximum amount of metal, thereby increasing its ability to overcome the resistance of the air, thus adding to its range and penetration; and *second*, accuracy. By giving a projectile a rapid rotary motion about its longer axis overcomes its inclination to turn end for end, gives it greater stability by distributing over its whole area of resistance any defects or inequalities in the structure of the projectile itself.

The rotary motion is communicated to the projectile either (1) by giving a peculiar shape to the bore, as in the English Whitworth gun (a hexagon), (2) by studs on the body of the projectile to fit into corresponding grooves in the gun, as in all early European systems, now abandoned, or (3) by a band of soft metal — copper or brass — fitted to the base of the projectile and forced into the grooves of the gun by

the explosion of the charge. This is now the universally adopted system.

With the stud system, the grooves in the gun were *few* and *deep*, relatively; but with the expanding system they are many and shallow. In our new 8-inch Navy guns the grooves are .05 inch in depth and 32 in number, with increasing twist.

The Velocity of Rotation of a projectile depends on the "twist" given to the grooves, which is measured by the length of one complete turn of the spiral. Formerly, this was usually uniform, with one turn in about 40 calibres, or twice the length of the gun. Now, with increasing twist, it begins with one turn in from 120 to 140 calibres, and ends in one turn in from 30 to 40 calibres.

Among modern field-guns, Krupp's 9.6 cm. (3.46 in.) may be taken as a representative of European guns. It weighs 1375 pounds, carries a shell of 26 pounds, has a carriage of compressed steel plate, and is provided with a simple break to take up the recoil. At 30 degrees elevation it has given a range of 9,000 yards; and in practice, out of 6 shots fired at a target $16\frac{1}{2}' \times 16\frac{1}{2}'$, at 2,200 yards, 5 shots struck the target, with a mean horizontal deviation of only 13 inches and a vertical deviation of 28 inches.

It should be stated that 15 degrees is about the maximum practical elevation for field-guns. With

this elevation, the 3.6 cm. gun has a range of about 6,000 yards.

Among heavy guns, Krupp's 119-ton guns are the heaviest yet constructed and in actual use. Three were made for the Italian government. They have a calibre of 15.75 inches, a 2,000-pound shot, and use 800 pounds of powder. In a recent practice at 2,700 yards, in 9 shots there was but 1 metre vertical and 2 of lateral deviation.

In the United States our dependence is still largely upon the 15-inch smooth-bore, with a 100-pound charge and 450-pound projectile. Of rifle guns, we have a few 6 and 8 inch muzzle-loading rifles in the land service, converted from smooth bore, cast-iron pieces, by boring out and inserting a steel tube. In the Navy we have 6, 8 and 10 inch breech loading built up rifles. Of experimental guns for the land service, we have under construction a 12-inch breech-loading cast-iron rifle, tubed with steel: a similar piece, both hooped and tubed with steel; two breech-loading 10-inch wire wrapped rifles—one of steel and one of cast iron; a 12-inch rifled breech loading mortar, which has already been finished, and tested with remarkable results, both as regards range and accuracy. A 6 inch rifle of Bessemer steel, cast at Pittsburgh by a private firm and finished at the Washington Navy Yard, and from which much was expected

by its designers, has just been tested at Annapolis, and burst at the second round.

MODERN OR MACHINE RAPID-FIRING GUNS.

These have been divided into three general classes: (1) Machine Guns, (2) Machine or Revolving Cannon, and (3) Rapid-firing Guns.

A Machine Gun has been defined as a single or multi barreled gun, mounted on a stand or carriage, which feeds, loads, fires and ejects the empty cartridge cases automatically. These guns usually use small-arm ammunition, although any gun of this kind having projectiles of less than 400 grammes (15 oz.) comes under this class.

A Machine or Revolving Cannon is like a machine gun, except that it uses projectiles of more than 400 grammes, and does not always *fire* automatically.

A Rapid-firing Gun is a breech-loading gun, mounted on a stand or carriage, using metal cased, gas-checking, self-primed projectiles, and from which the cartridge case is ejected by the action of operating the breech-block. It is not loaded nor fired automatically.

Of the first class, the pioneer was the French Montigny, the mitrailleuse which figured in the Franco-German War. It was a clumsy piece, firing

but 150 shots per minute. The American Gatling may be taken as a typical arm. It has ten barrels, revolving about a central spindle, of .45 inch and 1 inch calibres. The smaller calibre uses small-arm ammunition, and can fire 1,200 shots per minute. The Gardner has two barrels, also uses small-arm ammunition, and can be fired 350 times per minute.

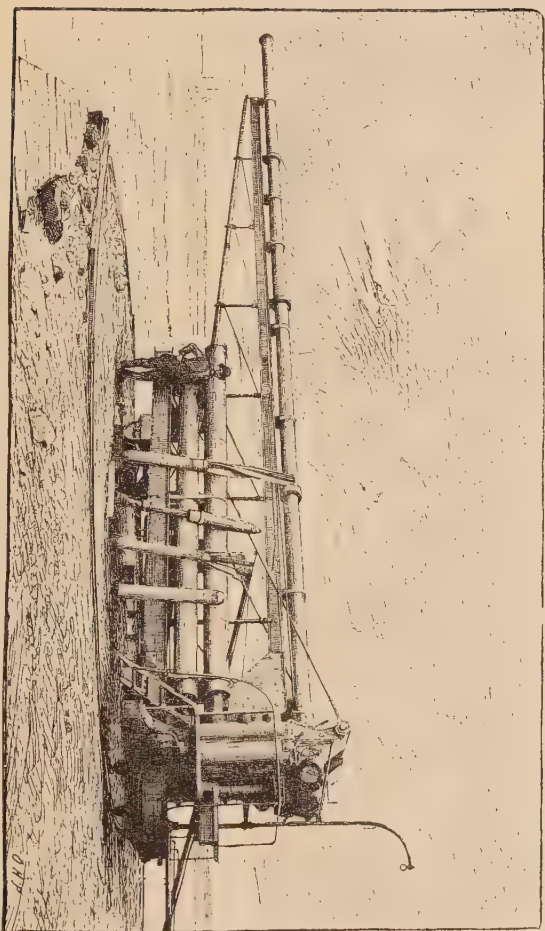
The Maxim is the latest pattern of this class of gun. It has a single barrel, mounted on a tripod, and uses service ammunition. It is automatic throughout. After the first fire, the recoil extracts the empty shell, loads and fires automatically as long as cartridges are supplied. These are arranged (333) in a single row upon a tape, and by engaging one end in the mechanism, one is drawn after the other until the tape is exhausted. It weighs but 85 pounds, and can fire 600 shots per minute, requiring but one man to operate it.

Of the second class, there is the Hotchkiss, with five barrels, of various calibres, the largest throwing projectiles of 2 and 4 pounds weight, at the rate of about 60 per minute; the Nordenfeldt, with from 1 to 10 barrels, of a variety of calibres, the largest having a projectile of about 4 pounds. With the 5 and 10 barrel guns, the shots can be fired singly or in volleys. On a spurt it can be fired at the rate of from 600 to 800 shots per minute. Both

the Hotchkiss and Nordenfeldt use steel projectiles — shot and shell — and form a part of the armament of every modern vessel of war, as a weapon against torpedo boats and for sweeping the decks of an enemy's ship.

Of the third class, the Armstrong, Hotchkiss and Nordenfeldt are the principal systems. In this class of guns, each projectile is handled separately. They differ from the ordinary field-gun in that the ammunition is "fixed"—that is, the charge and projectile is secured in a metal case, much like a round of rifle ammunition. The projectiles are of various weights from 3 to 70 pounds. Armstrong has a 36 and a 70 pounder, and is reported to be fabricating a 100 pounder. It is claimed that the 70 pounder can be fired 3 to 10 rounds per minute. Hotchkiss has a 3, 6 and 33 pounder. The 6 pounder can be fired, with fair aim, 15 shots per minute.

The Dynamite Gun (See Plate) is the latest addition to projectile-throwing machines. It is simply an air-gun, the propelling force being compressed air. It is a long tube of wrought iron, lined with brass—60 feet in length and 8 inches in diameter—mounted on a truss having both vertical and lateral motion. It is intended wholly for throwing a projectile containing a large charge of the high explosives. The projectile is a case of thin steel, with a tail-piece



LIEUTENANT ZALINSKI'S EIGHT-INCH PNEUMATIC TORPEDO GUN.

of wood, the whole being about 6 feet in length. It has a range of about two miles. At a mile it has wonderful accuracy. The air can be used at a pressure of 1000 pounds per square inch. The charge of the shell is 100 pounds explosive gelatine. The new dynamite cruiser *Vesuvius* has an armament of three pneumatic guns, built into the ship. They are 54 feet long, with a 15-inch bore, and made of thin cast-iron. The shell, when fully charged, will contain 600 pounds of dynamite, or other high explosive.

Below is given a table showing the best guns now adopted, or undergoing trial, by the different powers.

<i>Country.</i>	<i>Character of Gun.</i>	<i>Weight, tons.</i>	<i>Calibre, inches.</i>	<i>Powder, lbs.</i>	<i>Shot, lbs.</i>	<i>Muzzle Velocity.</i>	<i>Energy, foot-tons.</i>	<i>Length of bore Cals.</i>	<i>*Penetration at 1000 yds. in wt. iron, in.</i>	<i>†Cost.</i>
England.....	Steel B. L.	19	9.2	375	380	2520	18,728		23.2	†
England.....	Wrt. Iron and Steel M. & B. L.	100	17.75	575	2000	1735	46,300	20	28.5	\$78,000
England.....	Steel B. L.	111	16.25	900	1800	2128	57,304	30	32.5	
France.....	" " "	75	16.5		1720	1739	36,000			
Germany.....	Krupp Steel B. L.	71	15.75	485	1715	1700	34,500	20	23.8	\$99,000
Germany.....	Krupp Steel B. L.	105	15.75	900	2000	2019	56,500	35		
Germany.....	Krupp Steel B. L.	119	15.75	800	2200			35	39	
Russia.....	Steel B. L.	80	16							
United States..	Cast-iron B. L.	55	12	250	800	1700	16,187	28	19.5	\$29,000
United States..	Steel B. L.	13	8	113	300	1875	7,000	30		
United States..	" " "	29	10	250	500		24,000	27.6		

Krupp is now making a 150-ton gun of 17.5 calibre, and the English have designed a 19-inch 156-ton gun.

* A pointed projectile will penetrate about its diameter in wrought iron for every 1000 feet of velocity at moment of impact—i e., if 2000 feet velocity, twice its diameter. For penetration in steel, an allowance of from 25 to 30 per cent. must be made.

† A steel built-up gun will cost about \$1000 per ton.

‡ Wire wound, experimental.

Chapter XI.

PRACTICAL GUNNERY.

The Science of Gunnery treats of projectiles and their effects. *Ballistics*, that branch of it relating to their motion.

The *trajectory* of a projectile is its path through the air. This is a modified parabola, the descending branch being shorter than the ascending.

The *initial velocity* is the velocity with which a projectile leaves the muzzle of the gun, and is expressed by the number of feet passed over in a second of time. This is measured by electro-ballistic machines of various kinds. These machines consist essentially of two wire targets in the path of the projectile, near the muzzle of the piece, each in a separate electrical circuit, and connected with the electro-ballistic machines proper. The projectile cutting successively the wires of the targets, breaks the currents. The breaking of the first circuit releases a weight, a pendulum, or projects a spark upon the blackened surface of a rapidly revolving cylinder; the breaking of the second marks the distance through which the

weight has fallen, the length of the arc described by the pendulum, or the revolution of the cylinder; then

$\frac{\text{space}}{\text{time}} = \text{velocity}.$

The early artillerists ignored the resistance of the air in calculating the trajectory of a projectile, taking the trajectory in vacuo as a true expression. This is nearly correct for heavy projectiles thrown with moderate velocity, but under no other conditions.

The resistance of the air to a projectile increases with the velocity, but no *exact* law for this increase is known. It is found approximately that the resistance of the air varies as the cube of the velocity. This is nearly true for a certain range of velocity, but is by no means a general law. The exact amount of the resistance at any velocity is obtained by the use of a coefficient K, which varies with the velocity. The value of K has been found by calculation from the results of many experiments at various velocities, with oblong projectiles, between 100 and 2,900 foot-seconds, and tabulated.

The mathematical expression for the resistance of the air may be written

$$R = d^2 \frac{k}{g} \left(\frac{v}{1000} \right)^3 \text{ lb. avoirdupois. (A)} \text{ in which}$$

d = diameter of projectile in inches.

g = acceleration of gravity in feet-seconds.

v = velocity in feet-seconds.

k is a coefficient varying with the velocity, and given in Bashforth's table.

d^2 is employed since the sectional area varies as the *square* of the diameter. The constant g appears in order to reduce absolute to ordinary gravitation units. The variable coefficient K allows the use of the simple relation that the resistance varies as v^3 . 1000^3 is used for convenience only, to avoid an unnecessary number of ciphers in the value of K , as otherwise it would be a very small decimal.

In calculating the value of K , the use of the different measures of length in the above expression (*i. e.*, inches and feet-seconds) is taken into consideration.

If the pressure of the air in pounds on what is called the circular inch—a circle one inch in diameter—is represented by p the above equation becomes

$$p = \frac{k}{g} \left(\frac{v}{1000} \right)^3 \text{ lb.} \quad (\text{B})$$

From this formula a table may be calculated for different velocities, and the resistance on a projectile of any other diameter can be found by multiplying by the square of the diameter in inches.

The values of the coefficient K , as calculated, are for a certain shape of head of projectile (with curve struck with a radius of $1\frac{1}{2}$ diameters), and for normal atmospheric conditions. When any other shaped projectile is considered, or the density of the atmos-

phere is not normal, certain corrections must be applied to K , and the equation for the resistance becomes

$$R = d^2 \phi \tau \frac{k}{g} \left(\frac{v}{1000} \right)^3 \text{ lb. avoirdupois.} \quad (C)$$

In which ϕ is an empirical factor depending on the shape of the projectile and its steadiness of flight, and τ a factor depending on the density of the air — barometric pressure, temperature and humidity being considered.

The Loss of Velocity due to this resistance may be calculated by the aid of the above equation. The effect of a pressure or resistance (R) acting on a projectile is to cause acceleration (in this case a *retardation*) in the velocity, represented by f , and the *amount* of it is known from the law of dynamics expressed by the proportion:

$$r : w :: -f : g.$$

Where w = weight of projectile in pounds.

$$\text{Hence, Retardation } f = -\frac{r}{w}g.$$

Substituting the value of R from the preceding equation, we have

$$f = -\frac{d^2}{w} \phi \tau k \left(\frac{v}{1000} \right)^3 \quad (D)$$

Which is the rate of loss of velocity in feet per second caused by the resistance R in pounds.

It will be seen from equations (A), (B), and (C), that the *resistance of the air* is independent of the weight of the projectile, but from equation (D) that the *retardation* is inversely as the weight. Hence, with projectiles of the same diameter, and moving with the same velocities, the resistances are equal, but the retardation on the heavier is less than on the lighter.

Example:—Find the resistance of the air and retardation to a 125-inch shell, moving at a velocity of 1,400 f.s., atmospheric conditions normal. Weight of shell = 802.25 lbs.; diameter of shell = 12.5 in.

Substituting in (A), (K for 1,400 f.s. velocity = 104.7).

$$r = (12.5)^2 \frac{104.7}{32.19} \left(\frac{1400}{1000}\right)^3 = 1395 \text{ lbs.}$$

$$f = \frac{12.5^2}{802.25} (104.7) \left(\frac{1400}{1000}\right)^3 = 55.96 \text{ feet-seconds.}$$

The above represents the resistance and rate of retardation at the *instant* that the velocity is 1400 f.s.

Deviation of Projectiles. Oblong projectiles deviate from various causes, but the principal one is "drift." This with guns having a right-handed twist, is to the right, and is caused by the rotation, the resistance of the air which acts at the centre of the figure, and the consequent inclination of the projectile to turn about its shorter axis. The resultant of these antagonistic forces causes the projectile to

move to the right of the plane of fire. With the Springfield rifle the drift is 5 inches at 300 yards, and 43 inches at 1000 yards. The rotation of the earth is another cause of deviation where the direction of fire is not due east or west.

There are three kinds of fire,—*direct*, *vertical* and *ricochet*. The first is indicated by its name; the second, that of mortars, usually fired under an angle of about 45 degrees, in which the descending branch of the trajectory is vertical; and the third, where the projectile striking water or earth under a small angle makes a series of rebounds, or *ricochets*. It is only effective with spherical projectiles.

Rapidity of Fire depends largely upon the means of loading. On shipboard, where this is done by machinery, the 100-ton gun has been loaded by three or four men in less than a minute. It takes about five minutes to sponge, load, aim and fire one of our 15-inch guns. Field guns can be fired from two to four times a minute, in guns of moderate length, muzzle-loaders quicker than breech-loaders.

The Range of a Projectile is varied with mortars by increasing or diminishing the charge of powder: with guns, the charge remains constant, and range varied by a change of the angle of elevation. The extreme range and the particular range of a gun are two quite different things. The extreme range

of the best heavy gun is about twelve miles. On shipboard the greatest elevation that it is possible to give this piece, will give a range of about seven miles. In land batteries a greater degree of elevation can be given, but the difficulty of controlling the recoil, and the enormous strain brought upon the carriage when a gun is fired under high angles, are such as to reduce the practicable to between a half and two-thirds of the possible range.

The Penetration of Projectiles into parapets of earth, well settled or rammed, is, for field guns, from 10 to 15 feet; for siege guns a little more; the 15-inch smooth-bore gun about 22 feet, but against the best modern rifled ordnance a thickness of from 70 to 75 feet is necessary for perfect protection.

The standard of penetration for a modern high-power rifled gun is the thickness of *wrought-iron* plate its projectile will perforate. Roughly estimated this will equal one calibre for every thousand feet of velocity at instant of impact. Against steel plates an allowance of from 25 to 30 per cent. must be made.

Chapter XII.

PYROTECHNY AND PROJECTILES.

Pyrotechny treats of the preparation of ammunition of all kinds, fuses, primers, offensive and ornamental fire-works.

Projectiles are divided as to form into two general classes,—*spherical* and *oblong*. The first are used in smooth-bore, the latter in rifled guns. They are further divided as to structure into *solid*, *hollow* and *case shot*.

Solid shot are intended to act by force of impact alone; to batter down walls or heavy obstructions of any kind. *Armor-piercing shell* are allied to this class. *Case-shot* are almost identical in shape with this shell, as shown in the accompanying cut, the cavity serving to throw the centre of gravity well to the front. The aperture is closed with a screw-plug.

Hollow Projectiles are for use against animate objects; to set fire to buildings and destroy lighter obstructions. They are *shell* and *shrapnel*. A *shell* is a hollow projectile about two-thirds the weight of a solid shot of the same diameter, and contains a

bursting charge. A *shrapnel* is a shell of somewhat thinner walls than an ordinary shell, filled with bullets and containing a bursting charge. It is the most effective missile against troops and is chiefly so used.

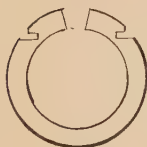
Under the head of *case shot* we have *grape* and *canister*. In this class of projectiles no bursting charge is used. The smaller projectiles making up the case separate of their own inertia after leaving the muzzle of the piece. *Grape shot*, or a stand of grape, consists of nine cast-iron balls held together by rings and a bolt and nuts. It has been entirely supplanted in warfare by the machine gun. *Canister* is simply a tin or sheet iron case filled with bullets. It is only effective at very short ranges—400 yards as a maximum.

The accompanying cut (Plate VIII) shows the general form of the projectiles above mentioned. Projectiles for rifle guns vary in length from $2\frac{1}{2}$ to $3\frac{1}{2}$ calibres. Rotary motion is communicated in two general ways; either by a copper or soft metal band at the base, which is forced outwards and into the grooves of the gun by the action of the powder-gasses, or by a like band of metal a little forward of the base of the projectile, and of a slightly greater diameter than that across the lands of the rifling, and is compressed into the grooves as it moves forward from the chamber into the rifled portion of the bore.

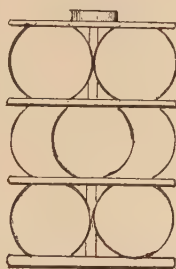
PLATE VIII



Shrapnel



Shell



Grape



Canister

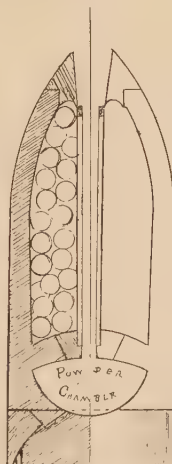
(For Rifled Guns)



Battering Shell



Common Shell



Shrapnel

Chilled iron, cast steel, chilled steel, hammered and tempered steel have all been experimented with against iron and steel armor-plates. The last has proved superior to all others. Steel projectiles of this kind are very expensive,—costing from 15 to 25 cents per pound.

Rockets (war) differ from other projectiles in that they carry the propelling force within themselves. The English war rocket (Congreve) is guided by a stick attached to the centre of the base. In Hale's American rocket stability is secured by giving the rocket a rotary motion about its longer axis. This is done by means of tangential vents on the side. It has no guide-stick. All war rockets are surmounted by a shell or solid shot at the head. Rockets have been but little used in late warfare.

Incendiary Fire-works, such as Greek-fire, fire-stone, etc., are compositions that burn slowly but with great intensity. They are placed in shell along with the bursting charge, to set fire to ships, buildings, etc., and are extinguished with great difficulty.

The composition for *ornamental fire-works* is usually charcoal, sulphur and chlorate of potash, to which are added various ingredients to obtain brilliancy and the different colors.

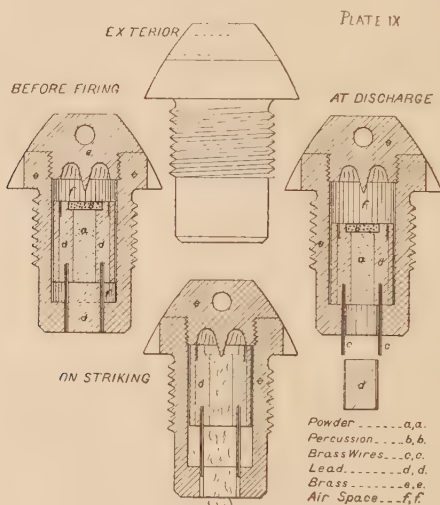
Fuses. A *fuse* is a contrivance for communicating fire to the bursting charge of a shell. It con-

sists essentially of a paper, wood or metal case containing a composition of the same ingredients as gunpowder. There are three general classes,—*time*, *percussion* and *concussion*, to which may be added the *combination*, which is both a percussion and a time fuse. A *time fuse* is one that can be cut or set to burn any desired length of time, up to the maximum of from 10 to 20 seconds. The rate of burning is regulated by the proportion of the ingredients and the density with which the composition is driven into the case. The composition is ignited by the flame from the charge. A *percussion fuse* is one that acts upon impact alone. It may be placed either at the head or base of the projectile. Where penetration is desired before explosion, as against armor-plates it is placed at the base. The projectile should strike point first to insure certain action. A *concussion fuse* acts whenever the projectile strikes a solid object. A *combination fuse* combines the principles of a time and a percussion fuse. If the time composition fails to act the percussion part comes into play upon impact; or the percussion arrangement may be made to act upon discharge and ignite a time composition. Plate IX shows the action of a Point Percussion fuse.

Primers. A *friction primer* is a contrivance for igniting the charge in a gun. It consists of two

hollow brass tubes soldered together at right angles; the longer one contains rifle powder, the shorter one a roughened wire and fulminate. The end of the wire is bent into a loop into which the lanyard is hooked. Heavy guns are now fired by electrical primers. In this primer the terminals are joined by a bit of fine platinum wire, and surrounded by a little fulminate or dry gun cotton.

Cartridge bags are made of woolen or silk material. Under no circumstances should cotton be used.



Hotchkiss Point Percussion Fuse.

Chapter XIII.

FORTIFICATIONS.

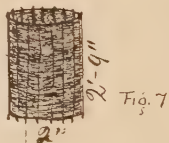
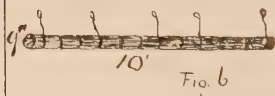
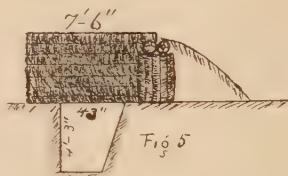
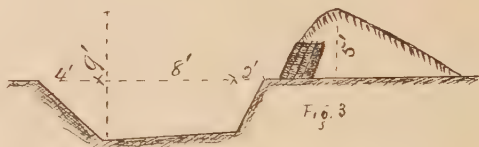
FORTIFICATION is any artificial protection against an enemy. They are of two general classes—Permanent and Field Works. The first are constructed of durable materials and with great care, and are intended for permanent occupancy. The second are for temporary use only; often hastily constructed, usually of earth or timber, or any material that may be at hand that will afford protection.

FIELD FORTIFICATIONS.

Under the conditions of modern warfare the spade has become almost as much of a soldier's weapon as the rifle, and in nearly all European armies a certain number of men in each company—usually every fourth man—carry a short-handled spade for intrenching purposes.

The simplest form of fortification is the *simple trench* (Fig. 1, Plate XII.)—a ditch with the earth thrown toward the enemy, affording cover from his fire but no facilities for offensive action, unless means are provided for the delivery of fire, and for advancing over the parapet, as in Fig. 2.

PLATE XII

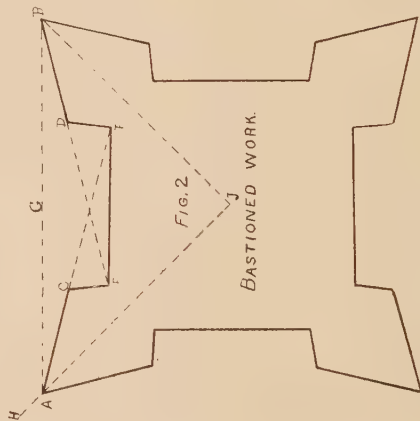


For artillery defence, something more than a parapet is needed — something that will present an obstacle to the advance of infantry against the guns. This takes the form of a parapet and ditch, in which the earth from the ditch is thrown in direction from the enemy to form the parapet, the ditch offering a serious obstacle to assault. Its general form is shown in Fig. 1, Plate X., and its nomenclature is as follows: A-B, Banquette Tread; B-C, Banquette; C-D, Interior Slope; D-E, Superior Slope; E-F, Exterior Slope; F-G, Berm; G-H, Scarp; J-K, Counter-scarp; L-M, Glacis; D, Interior Crest; E, Exterior Crest; T, Abattis.

Of simple field-works for artillery defence, we have the *Redan* (Fig. 4) and the *Lunette* (Fig. 5). The first is a work of two faces only, like an inverted V; the second has two flanks added. The objection to this class of works is that they are open at the “gorge.” This is remedied by enclosing the entire work with a parapet, when it takes the name of *Redoubt*. Any *enclosed* work is so called. It may be of any regular figure; if a square, with lunettes added to the sides, it becomes a *star fort* (Fig. 3).

The most perfect form of a fortification is a *bastioned work*. It is the only work that secures fire over every possible direction of approach, as well as upon all parts of the ditch. It may have for its basis

FIELD WORKS



any regular figure, usually a square or pentagon. Its form is shown in Fig. 2, and its nomenclature is as follows: A-B, Exterior Side; A-C and B-D, Faces; C-E and D-F, Flanks; A-F and B-E, Lines of Defence; J-H, Capital.

In the construction of field-works, the line of the *interior crest* (D, Fig. 1) is that from which all horizontal distances are measured. The *command*, or height of the interior crest above the natural level of the ground, should never be less than 8 feet; the thickness of the parapet not less than 12 feet; the depth of the ditch at least 8, and its width at least 12 feet. If for defence against anything heavier than field-guns, both the thickness and height of the parapet should be considerably increased.

To ascertain, in a rough way, the width of ditch necessary to furnish sufficient earth for a parapet of given thickness, divide the area of the profile of the parapet by the assumed *depth* of the ditch.

A *revetment* is a facing of stone, sod, sand-bags, timber, etc., for holding earth in position. A *fascine* is a bundle of small twigs bound together, with a usual dimension of 9" x 10' (Fig. 6, Plate XII). A *gabion* is a wicker basket open at both ends—2' x 2' 9" (Fig. 7). Both are used for revetments, and also in siege operations.

PERMANENT FORTIFICATIONS

Up to the time of the introduction of rifled guns of high power, all permanent works were of masonry, and of the most elaborate design and construction. In the permanent work of to-day, iron has in large measure superseded all other materials. Modern fortifications have taken the form of turrets — revolving or stationary — cupolas, casemated and ironclad batteries, of cast-iron, wrought iron or steel. All the continental powers, except France, have adopted the Grüson chilled cast-iron plate for turrets. These are cast in curved form, the larger plate having a thickness of 49 inches at the centre, and decreasing towards the top and bottom.

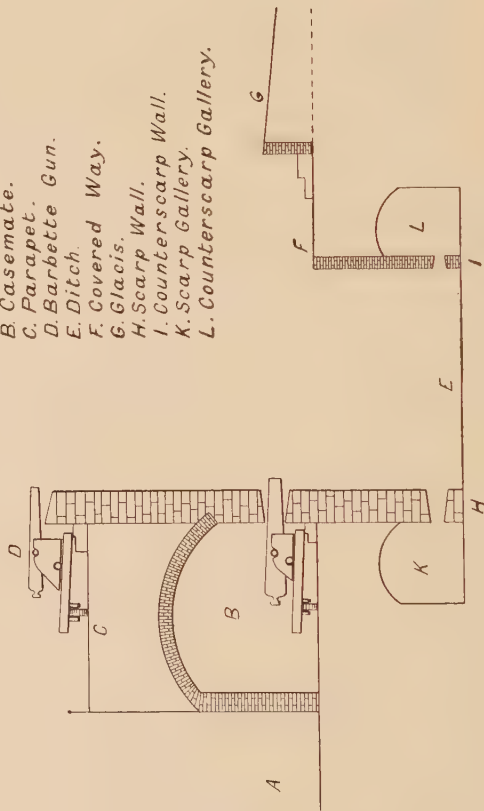
Up to the present time, the English have used wrought-iron exclusively in the construction of turrets for sea-coast defence. Compound plates, of wrought-iron faced with steel, are likely to be used in future. In France the all-steel plate is employed in turret construction, alone or in combination with concrete backing.

As regards cost, the Grüson cast-iron plates can be manufactured for from \$150 to \$200 per ton; wrought-iron plates, from \$220 to \$330 per ton; the French all-steel plate, about \$380 per ton, and the largest compound plates, weighing about 50 tons per plate, about \$450 per ton.

In the construction of permanent works for land defence, as of a city, a continuous line would never be attempted. Resort would be had to lines of detached works placed on commanding points and in defensive relation to each other, care being taken that no spot between adjacent works is unswept by artillery fire.

The accompanying cut (Plate XI.) represents, in vertical section, a fortification of the old school, with the nomenclature of the work.

- A. Interior of Work.*
B. Casemate.
C. Parapet.
D. Barbette Gun.
E. Ditch.
F. Covered Way.
G. Glacis.
H. Scarp Wall.
I. Counterscarp Wall.
K. Scarp Gallery.
L. Counterscarp Gallery.



Chapter XIV.

SIEGE OPERATIONS.

SIEGES are undertaken for the capture of places that cannot be carried by open assault.

The first step to be taken by the besiegers is, if possible, to completely surround the place, cutting it off entirely from communication with the outside world; then to provide for defense against attacks both from within and without; to construct magazines and store houses, and to collect all the material needed for subsequent operations. This is called the First Period.

The point chosen for attack is usually the salient of a bastion and its adjacent out-works.

When everything is ready the Second Period begins with the opening of the first parallel.

The Parallels are wide ditches, three or more in number, having a general direction parallel to the besieged work, and of sufficient length to envelope the point of attack. Here are brought all the tools and materials to be used, and here the guards for the protection of working parties are posted.

The Boyaux are the trenches, or ziz-zags, run forward from the parallels. They are given such direction that they cannot be enfiladed from any part of the besieged work.

In running the parallels the "simple trench" can usually be employed, but for the boyaux the "flying-sap," the "full sap," or the "double sap" will have to be resorted to, depending on the direction and severity of the enemy's fire.

In Plate XII, Figs. 1 and 2 represent in profile the simple trench; Fig. 3 a flying sap; Fig. 4 a longitudinal, and Fig. 5 a cross-section of a full sap.

In the *simple trench* cover is obtained by excavating to the required depth and throwing the earth toward the side of the enemy. In the *flying sap* each man, to obtain speedy cover, is provided with two gabions, which he plants side by side, and fills with earth as quickly as possible. In the *full sap* it is necessary to provide for protection ahead as well as on the side, and for this purpose a heavy *sap-roller* is provided. This is a large wicker-work or sheet-iron gabion stuffed with fascines (shown in Figs. 4 and 5). This is placed at the head of the sap and rolled ahead a few inches at a time, the space being filled in with earth at once. The *double sap* provides for protection on *both* sides and in front. Two sap-

rollers are used, placed end to end, and the excavated earth thrown in both directions.

While the boyaux are being pushed forward, and particularly after the construction of the second parallel, the batteries are constructed. *Breaching batteries*, to batter down the walls and make a practicable breach; *Enfilading batteries* to enfilade and dismount the guns along the faces of the work.

In this way the besiegers gradually work their way forward up to the covered-way in front of the ditch. From this point an assault may be made, or the approaches continued down to and across the ditch up to the wall of the main work, which, in the meantime, is supposed to have been breached by the besieger's batteries.

The Second Period embraces all work from the opening of the first to the completion of the latter parallel, and the *Third Period* the assault and all subsequent operations.

Mining and countermining are frequently resorted to, and desperate encounters often take place in these underground operations.

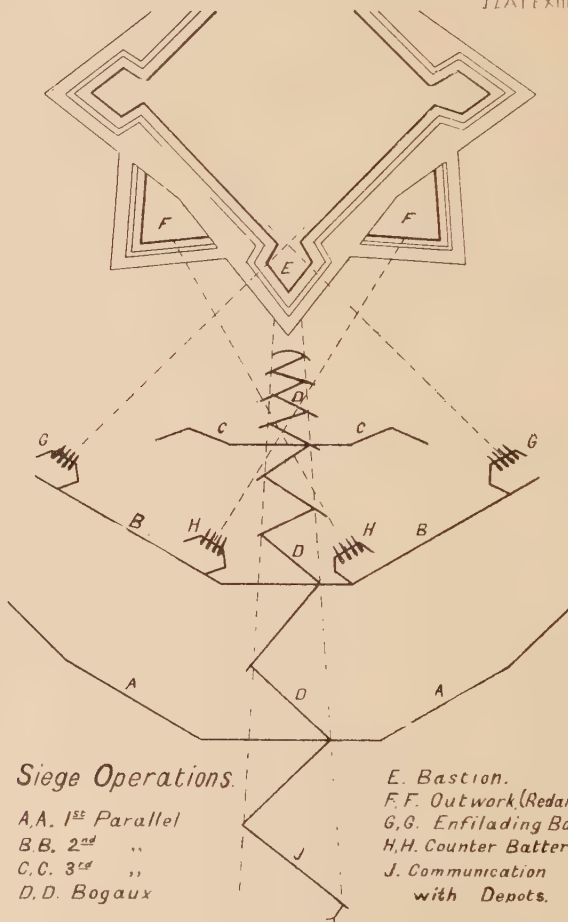
In the days of smooth-bore guns the first parallel was usually opened about 600 yards from the besieged work, and three parallels were usually sufficient to carry the attack forward to within assaulting distance; but under modern conditions the first

parallel would probably be opened many times this distance. At the siege of Strasburg, during the Franco-Prussian war (1871), the Germans opened their first parallel at 4000 yards from the French works. Their breaching batteries were established, and the walls breached at a distance of 3500 yards. The siege of Fort Pulaski, in 1862, proved that rifled guns of moderate power could breach walls of masonry at the distance of a mile or more, and, in effect, sounded the doom of masonry as a material for fortifications. The siege of Fort Sumpter, a year later, confirmed the lesson of Fort Pulaski. Here the walls of Sumpter were reduced to a shapeless mass of rubbish by the fire of the Federal fleet, and batteries firing at distances of from 1,200 to 4,000 yards.

The siege of Fort Wagner, one of the defenses of Charleston, in the same year, demonstrated the value of sand as a material for parapets. The approaches were conducted in the regular way, the fort in the meantime being subjected to the combined fire of both the fleet and the shore batteries at short range. Its guns were dismounted, but the thick sand parapets were found to be comparatively uninjured when the work was abandoned, which was done the night after the besiegers had reached the crest of the covered-way with their approaches. It should, how-

ever, be added that the great thickness of parapet necessary to stop hostile shot; the impossibility of using it in restricted places, and the want of protection it affords against vertical fire, are inseperable objections against the employment of earth or sand for the construction of permanent fortifications.

The accompanying cut (Plate XIII) will show the manner in which siege operations are generally conducted.



Siege Operations.

A.A. 1st Parallel

B.B. 2nd ..

C. C. 3rd , ,

D. D. Bogaux

E. Bastion.

F. F. Outwork, (Redan.)

G.G. Enfilading Bat'y.

H.H. Counter Batteries

*J. Communication
with Depots.*

Chapter XV.

TORPEDOES AND SUBMARINE MINES.

ALL contrivances for producing explosions calculated to act destructively against an enemy are called *mines*. They are used chiefly to defend rivers and harbors. When *stationary* and so employed, they have received the name of *submarine mines*, leaving the term *torpedo* for all offensive and *movable* combinations of this nature.

SUBMARINE MINES.

Submarine mines are of two classes — (1) mechanical and (2) electrical. *Mechanical*, those which depend for their explosion upon mechanical means, as the percussion of a vessel coming in contact with them; *electrical*, those which are fired by electrical agency, either by the vessel itself closing the circuit, or at will from the shore.

The first, when once in position, bar the harbor or channel against friend and foe alike; the second are under perfect control, and may be rendered harmless at any instant by simply cutting out the battery. The only advantage of the mechanical over the elec-

trical mine is that it is of simpler construction, and may be handled and planted by ordinary workmen, while the electrical mine requires a certain amount of technical knowledge for its proper manipulation.

In planting a system of mines for the defence of a channel or harbor, the individual mines may be arranged in groups, or singly, upon one or more lines, and near enough together to bring within the destructive area of one or more of them any vessel attempting to enter. When the depth of water is not too great, they should rest upon the bottom.

The case may be of wood or metal—usually of thin steel; must be water-tight, and in shape may be either spherical, conical or cylindrical.

They are called *buoyant* or *ground mines*, according as they are anchored from, or rest upon, the bottom. For depths beyond six fathoms the buoyant mine would be employed.

The explosive may be either gunpowder or some one of the high explosives. The latter are to be preferred, both on account of their greater explosive force and the fact that they are unaffected by the action of water.

The charge is fired by an electrical fuse (except in case of mechanical mines). A current of any kind may be used, but that from a galvanic battery is to be preferred, as it gives a current of large quantity

and low tension, and is not likely to excite induced currents in the wires of contiguous mines.

The positions of the mines of a system are carefully located by means of intersection of lines from fixed points on shore. There must be no indication of their position above water.

Fig. 1, Plate XIV., shows one method of fixing the position of and firing a system of mines by means of intersection of lines. Two operators are necessary, at A and B, at each of which points there is a break in the circuit, which, however, is closed as long as a hostile vessel is upon any one of the intersecting lines. When a vessel is over any mine, *both* circuits are consequently closed and the mine is fired. The circuit may be closed automatically by the telescope of the observer, or it may be done by means of a key-board in front of him.

Fig. 2. The ordinary buoyant mechanical mine. An arrangement of percussion nipples, or caps, serves to insure explosion on contact with a vessel. It would be anchored from 10 to 20 feet below the surface of the water, depending, of course, on the depth of channel and the size of craft that would be likely to enter.

Fig. 3. A ground mine. Usually a hollow cast-iron body, and rests upon the bottom of the channel. It may be fired at will, by an electrical fuse or

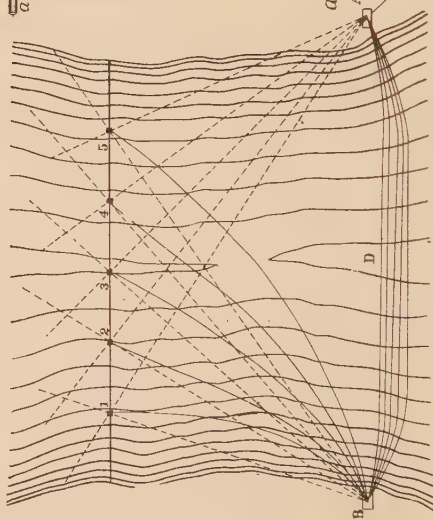


Fig. 1.

A, B, Stations. C, Battery. D, Electrical Cables.
1, 2, 3, 4, 5, Mines.

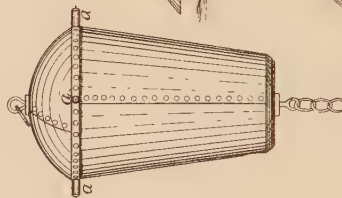


Fig. 2.

a, a, a, Percussion
NIPPLES.



Fig. 3.

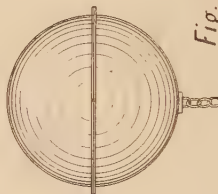


Fig. 4.



may be made automatic by a buoy having precisely the same arrangement for closing the circuit, on contact, as a live mine, and with which it must be, of course, electrically connected.

Fig. 4. A spherical, buoyant mine. This form has been adopted by the United States Engineer Department. The case, of thin hemispheres of steel, bolted or welded together, is 32 inches in diameter, and has a capacity for 100 pounds of explosive,—dynamite or nitro-gelatine. It is fired by an electric fuse, and may be exploded at will, from the shore, or the contact of a passing vessel may be made to close the circuit and fire the mine.

A system of submarine mines can, at best, be only auxiliary to guns and forts. Without the protection of batteries, mines can be readily removed, killed or exploded,—an operation for which provision would always be made in the plans for an offensive movement against a harbor or channel.

TORPEDOES.

Torpedoes are of two classes,—Controllable and Projectile.

In the first class the torpedo carries within itself the engine that supplies the motive power to propel it, and is steered from the shore by an electrical cable,—a float above the surface of the water indicat-

ing the position of the torpedo. The engine may be driven by carbonic-acid gas; by compressed air, or by electricity supplied from the shore by cable.

The range of this class of torpedoes is limited only by the length of the cable and the distance at which the float can be seen. One mile seems to be the range claimed for the best of them.

They are cigar-shaped; varying in length from 20 to 36 feet, and carry from 200 to 450 pounds of dynamite or gun-cotton. The Controllable torpedo, of which there are various models, is essentially an American invention.

Fig. 1 represents the *Patrick Auto-Mobile Torpedo*. It is driven by a carbonic acid gas engine. Buoyancy is attained by means of a hollow copper float, which maintains the torpedo at a submersion of about three feet. The torpedo is 36 feet long and 22 inches in diameter. The float is 5 feet longer than the torpedo, to which it is rigidly connected. Two flags above the float indicate to the operator the position of the torpedo. It is started, stopped and guided on its course by means of a two-wire electric cable in connection with a Bunsen Battery. It is charged with 200 pounds of dynamite, which may be fired electrically at will, or on contact.

In the *Sims-Edison* torpedo, the motive power is electricity, supplied by a dynamo machine on shore,



(Fig 1.)

THE CONTROLLABLE AUTO-MOBILE TORPEDO.

through a cable. The cable is coiled in a compartment within the torpedo and is payed out as the torpedo proceeds. It is not only propelled, but steered and fired by electricity. Buoyancy is obtained, as in the case of the Patrick torpedo, by means of a float. Its position is determined by means of two globes above the float, which at night carry lanterns, whose light is invisible from ahead.

In the *Nordenfelt* electrical torpedo, the motive power is supplied by 120 storage cells, which are said to develop power to drive a 6000 pound torpedo 15 miles per hour. The storage battery and motor are within the torpedo, which is steered by a balanced rudder, manipulated from shore through a cable. It has a length of 35 feet; moves 6 feet below the surface, and has a charge of from 200 to 500 pounds of explosive.



Of *Projectile* torpedoes the *Whithead* is the representative of European systems of torpedoes. It is an English invention. Unlike the other system the operator has no control over it after it is once launched against an enemy. It is carried in boats specially designed for the purpose, and is driven after striking the water, by a compressed air engine.

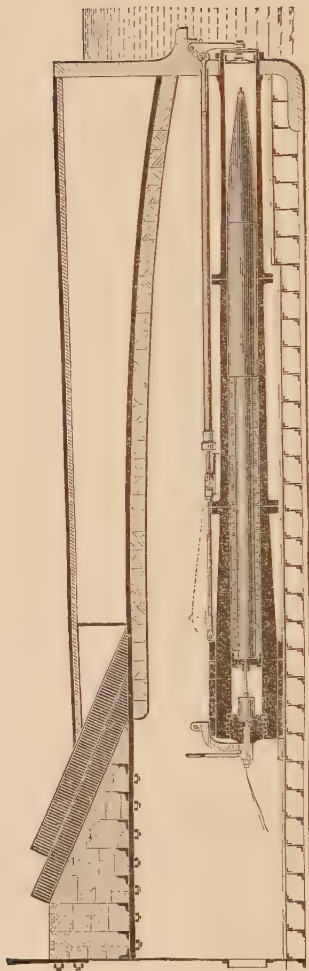
It has a range of from 450 to 600 yards, which it covers at the rate of nearly 30 miles an hour. Its general appearance is shown in the cut above.

The Howell torpedo, the invention of Captain Howell, of the Navy, has much the same general appearance of the Whitehead, and is claimed to be superior in accuracy, a quality in which the Whitehead is lacking. The screws are driven by a 110 pound steel fly-wheel, to which a rotary motion of 10,000 turns per minute is given before the torpedo is launched. The energy thus stored is sufficient to give the torpedo a range of 800 yards. It steers automatically.

The torpedo boats employed in carrying and discharging projectile torpedoes are of special construction, and are remarkable for their phenomenal speed. The best of them have attained a speed of nearly 30 miles an hour. The torpedoes are discharged from tubes in the bow, or, as in some recent models, from tubes at right angles to the keel.

Ericsson's torpedo boat *Destroyer*, recently purchased by the United States government, fires a projectile torpedo from a tube beneath the water. The torpedo is 25 feet long, and carries a charge of 300 pounds of gun-cotton. The impulse is given by a 25 pound charge of gunpowder.

The cut below shows the general arrangement of the armor-plating, gun, etc.,
of the "Destroyer."



CAPTAIN ERICSSON'S SUBMARINE GUN AND PROJECTILE.

Chapter XVI.

GRAND GUARDS, SENTINELS AND OUTPOSTS.

THE safety of an army engaged in active military operations depends largely upon the alertness and fidelity with which its guard duty is performed. The guards may be said to be the eyes and ears of the main body.

At all times, in peace as well as in war, every military post, camp or station has a regularly mounted guard. That for the protection of stores and buildings, and to control the ingress and egress of individuals, is termed the *Camp Guard*. It is never omitted in any weather or under any circumstances.

In time of war, in presence of an enemy, there are, in addition to the camp guard, other precautions taken to observe the enemy and prevent a surprise. This is done by advanced guard, consisting of two or more concentric lines spread out in fan-shaped order in front of the main body of the army, and so posted that no person can penetrate the line without being discovered.

The duties of the advanced guards, or *outposts*, as they are termed in foreign services, are the same in all armies, viz.:

1. To secure time for the main body to get under arms and ready to receive the enemy.
2. To obtain all possible information respecting the enemy.
3. To prevent the passage of unauthorized persons across the outpost line.
4. To secure undisturbed repose for the main body.

The troops employed upon this duty vary in different services. From one-fourth to one-eighth represents the average proportion. They are spread out on four lines, usually — (1) grand guards, (2) outposts, (3) sentinels and (4) videttes.

Grand Guards are usually made up of details furnished by the different regiments of the division whose front they cover. They are posted upon or near the roads or avenues of approach leading from the exterior line of outposts to the main body. They supply the men for, and act as support to the outposts.

Outposts. Outside the grand guard, and occupying a much more extended front, are the *outposts*. These consist of a line of small posts, each under command of a non-commissioned officer, posted within sight of each other, and, when practicable, within

view of the post of the grand guard. They should be concealed as much as possible from view of the enemy. A number of posts are placed under the supervision of an officer.

Sentinels. Outside the line of outposts are the individual sentinels, who should be within speaking distance of each other. At important points, or when an attack is apprehended, the sentinels are usually doubled. Upon roads or advantageous points for observation beyond the chain of sentinels, single individuals are sent forward to watch the enemy. They are called *videttes*.

Patrols. To keep up communication between the line of outposts, the outposts and sentinels, and the grand guards, patrols are employed, who, passing constantly between the different parts of the lines, keep each informed of the state of affairs of the whole line.

For obtaining information of the enemy, reliance must be had upon cavalry patrols, who often go out far in advance of the infantry outposts. As has been said, "Cavalry can hardly go too far or too often."

Often it is necessary to have a fourth line, or line of *reserves*, between the grand guard and the main body, to act as support. These reserves may consist of artillery as well as infantry, and always there will

be mounted men attached to the grand guards and reserves, to convey intelligence quickly to the main body.

The strength of the grand guards and their distance from the main line will depend upon the importance of the position, the facilities for defence which the ground offers, and the strength and enterprise of the enemy. The grand guards will usually be from one to two miles from the main line.

The sentinels and outposts are never allowed to sleep, nor more than half the members of the grand guards at one time, and never when an attack is apprehended. The sentinels are relieved at stated intervals from the grand guard posts. The horses of mounted men are always kept saddled and bridled.

In case of attack, the sentinels fall back upon the outposts, they in turn upon the grand guards, who, after offering as stubborn a resistance as possible, would fall back upon the reserves, if there be any; the duty of the whole being to hold the enemy in check long enough to enable the main body to prepare to receive the attack. The whole force of the advanced guard will, if driven in, enter the main line at certain designated and well-understood points.

To protect an army on the march from surprise or ambuscade is more difficult than to guard one in position. Not only the front, but the flanks and the

rear must be guarded. For this purpose we have an *advanced guard*, *flankers* and *rear guard*.

The *advanced guard* should consist of troops of all arms, and be of sufficient strength to receive the enemy and hold him in check until the main body can come up. It must carefully examine every spot of territory in front, drive off small bodies of the enemy, and make a surprise of the main body impossible.

The *flankers* march along each flank of the column and guard it from surprise in that direction. In an open country they would usually be of cavalry.

The *rear guard* finds its true function during a retreat. It must dispute every inch of ground, and, whenever the ground offers opportunity, halt and fight long enough to compel the pursuing force to deploy, when the retreat may be resumed.

Chapter XVII.

TROOPS IN CAMPAIGN.

THE general efficiency of a military force depends very largely upon the care exercised in preparing the individual soldier for the field. For this the captains of companies are almost wholly responsible, and it is proposed to state briefly the direction in which this care should be exercised.

The company, as the part of a larger force, is supposed to have received orders to prepare for a march. First, and most important of all, the captain must see that each individual is provided with the specified number of rations required to be carried on the person, that they are actually in his haversack, — the meat portion cooked; that he has the required number of rounds of ammunition in his cartridge-box or elsewhere upon his person, and that his arms are in good order. Next, and of the greatest importance, is the matter of the knapsack. Ordinarily, each soldier is supposed to carry in or on his knapsack a change of underclothing, an extra pair of shoes, towel and soap, besides an overcoat, a woollen and a rubber blanket. In this connection the captain

must see that only the authorized articles are present, and throw out, without compunction, every unauthorized article, however small, that he may find upon inspection. The proneness of soldiers to overload themselves, and the influence of each ounce added to their loads upon their marching power makes this caution necessary.

Sometimes, for forced marches, the extra clothing is carried in what is called the "blanket-roll." The articles to be carried are placed inside the blanket, which is then rolled up lengthwise, the ends tied together, and the roll slung over the right shoulder.

If nothing else can be secured, an extra pair of shoes and stockings should be. To be able to march well the feet require constant attention. In the Russian service the men, in place of stockings, are provided with a long strip of woollen cloth which is wound about the feet, and can be easily removed and washed. Recent experiments have been made in Germany of dispensing with stockings, and instead, requiring the feet to be kept thoroughly greased.

Tentage. In our own service, on ordinary marches, tents are provided. The common, or "A" tent, for the men, and wall tents for officers, which are carried on wagons. In the field the shelter tent alone is allowed. This is simply a piece of thick cotton-cloth carried by each soldier, with buttons and

eyelets along the edges, and by joining two or more pieces, partial protection against the weather is obtained. In nearly all European services, where campaigning is in a thickly settled country and towns numerous, the soldiers are billeted on the inhabitants, and no provision is made for tentage.

Marches. Ordinarily the day's march should begin as soon after daybreak as possible, and immediately after the men have had their breakfast. At the end of half an hour, a halt of fifteen minutes should be given, to allow attention to the calls of nature and a readjustment of the knapsack, etc. Thereafter a few minutes halt every hour should be given. If an early camp is to be made the midday halt will be a short one and no fires kindled. Otherwise, if wood and water can be obtained, fires will be built and coffee cooked. The day's march should end in time to allow the men to get comfortably established in camp before dark.

In selecting a spot for a camp, wood and water are the first requisites; next a spot that will not be flooded in case of a storm, and one that admits of good drainage. If a stream is to be crossed it should be done before the halt, and camp made on the farther bank.

In the arrangement of marches, the different regiments of a brigade usually alternate in leading the day's march.

The ground that can be covered in a day's march depends largely upon the systematic arrangement of the details. Two and a half to three miles per hour is a good marching gait, and from twenty to twenty-five miles per day an ordinary day's march. In forced marches a much greater distance can be covered. The march of one of the English divisions to join Wellington in time to fight at Talavera, which has become historical, that of one of Davoust's divisions, from Vienna to the field of Austerlitz—36 leagues in 48 hours,—and the wonderful marching feats of Stonewall Jackson's "foot-cavalry," in Virginia, show what men can do under stress of urgent necessity.

During a march no one is allowed to leave the column except by permission of his immediate commander. When soldiers leave the ranks, the arms and knapsack should be left with their comrades. In case of sickness and inability to march, the captain gives the man a note to the medical officer in charge of the ambulance. Straggling can only be prevented by the utmost care on the part of the company officers.

Chapter XVIII.

MILITARY LAW AND COURTS-MARTIAL.

MILITARY law is for the government of the military forces both in time of peace and in war.

Act I, Sec. 8, of the Constitution, says: "Congress shall have power to make rules for the government and regulation of the land and naval forces." The Regulations thus prescribed forms the statute law of the army. This law, so far as relates to discipline, is embodied in what are called the *Articles of War*,—128 in number.

These Articles were originally largely copied from the English Military Code, or Mutiny Act. They provide for the punishment of every infraction of the military law, and either prescribe the punishment or leave it discretionary with the court.

The Articles of War are enforced through the medium of a military court, called a Court-Martial. Courts-Martial are no part of the Judiciary of the United States, but simply instrumentalities of executive power. They are creatures of *orders*; the power to convene them as the power to act upon their proceedings, being attributes of *command*. Their judg-

ments, when rendered upon subjects within their jurisdiction, are as legal and valid as those of any other tribunal. Nor are the same subject to be appealed from, reviewed or set aside by the courts of the United States, or of any State. They are tribunals of exceptional and restricted power and jurisdiction,—being confined to distinctive classes of offences recognized by the military code. Their jurisdiction is *criminal*, their functions being to assign *punishment*. They have no authority to adjudge damages for personal injuries or private wrongs.

A General Court Martial may consist of from 5 to 13 members, and a Judge Advocate. It is convened either by the President; by a *General officer* commanding the army of the United States, a separate army, or a separate department.

The Judge Advocate appears as the representative of the government, and acts as the legal advisor of the court. He records the proceedings, and, with the President, authenticates the completed record, but he has no vote or voice in either the finding or sentence. The senior member present is the President of the Court.

General Court-Martial has jurisdiction, as to *person*, over every member of the military forces, and, in time of war, over all “retainers of the camp,”

which includes employes of the staff departments, telegraph operators, guides and engineers, and conductors on railroads operated for military purposes in the theatre of war.

Its jurisdiction as to *place* is co-extensive with the territory of the United States, and extends as well over all offences of a military character committed in a foreign country, when the offender is in such country in a military capacity and under military orders.

The commander convening a Court-Martial reviews and acts upon its proceedings. He may either approve or disapprove the proceedings and findings of the court, and may approve, mitigate or disapprove the sentence awarded; and, except in certain specified cases, his action is final. These exceptions are that in time of peace sentences involving the dismissal of officers or the death penalty, and in all cases those concerning General officers, must go to the President, whose action is the final one.

The indictment before a military court is termed the Charge and Specification. The Charge sets forth the Article of War, under which the offence falls; the Specification, one or more, the particulars as regards details, and as to time and place. It may be formulated and signed by any commissioned officer,

or by a staff officer, by order of his chief. It is forwarded through the regular military channels to the officer competent to convene a court, who may order a court or otherwise, as he may see fit.

The punishment that may be imposed by a Court-Martial are in part mandatory and in part discretionary. Of the mandatory punishments, ten of the Articles cover offences for which officers *must* be sentenced to dismissal. These are (1) mustering a person not a soldier, (2) taking money on muster, (3) making a false return, (4) making a false certificate as to absence or pay, (5) making a false muster, (6) suffering military stores to be damaged through neglect, (7) as commanding officer to be interested in the sale of supplies, (8) sending a challenge to fight a duel, (9) drunkenness on duty, (10) conduct unbecoming an officer and a gentleman.

Offences for which the death penalty *may* attach are thirteen in number. They are (1) striking a superior officer, (2) mutiny, (3) failing to resist mutiny, (4) sleeping on post, (5) creating false alarms, (6) cowardice, (7) compelling a surrender, (8) disclosing a watchword, (9) relieving an enemy, (10) corresponding with an enemy, (11) aiding or advising to desert, (12) violence to persons bringing provisions, (13) desertion in time of war. In addition, there are two crimes for which the death penalty *must* be

awarded by a Court-Martial,—forcing a safeguard, and as against spies.

Persons in the military service convicted of what may be called civil offences, such as theft, burglary, arson, etc., may be sentenced to confinement in a penitentiary or state prison, but only when the offence is such as by some statute of the United States, or of the state or territory where committed, or by common law, would subject the convict to such punishment.

In the finding and sentence of a military court the majority rule obtains: except in awarding the death penalty two-thirds of the members of the court must concur, which fact must appear upon the record.

Besides General Courts-Martial, which have jurisdiction in all cases, there are Garrison and Regimental courts. These have jurisdiction only in cases of enlisted men, and are for the trial of minor offences. They consist of three members and a Judge Advocate. In time of war these courts may be superseded by a Field Officers Court—a field officer detailed by proper authority to try such minor offences.

A Military Commission is a *criminal* war-court, which can have existence only in time of war, when the civil courts are closed and their processes cannot be served. It derives its jurisdiction primarily from

the law of war, and obtains in a locality where martial law has been declared by proper authority. It can take cognizance of two classes of offences committed by persons not in the military service, or non-military offences committed by soldiers:

(1). *Violation of the laws of war*, such as conspiracy or intercourse with the enemy, making and furnishing arms to the enemy, violation of parole by prisoners of war, aiding a prisoner to escape, cruel and inhuman treatment of prisoners of war, burning, destroying or obstructing bridges, etc. (2). *Civil Crimes*, which, because the courts are closed, cannot be taken cognizance of by the ordinary tribunals.

In short, a Military Commission, besides exercising under the laws of war a jurisdiction over offences peculiar to war, may act also as a substitute, for the time being, for the regular criminal judicature of the state or district.

It consists usually of three members and a Judge Advocate, and follows in its proceedings the methods of a Court-Martial.

Martial Law is simply the military authority exercised according to the rules and usages of war. It can only be declared in time of war, insurrection or rebellion, when the civil courts are closed, or when it becomes necessary to subordinate the civil to the military power. Martial law may be declared by

the President, by Congress, by a State, or by an independent military commander.

The Militia of a State may be called out by the Governor and certain other civil officers, for the suppression of riots or to execute processes where serious resistance is offered. The militia may also be called out by the President in times of national danger for a period not exceeding ninety days.

The military forces of the United States cannot be used as a *posse-comitatus* to enforce the laws within a State (*i. e.*, in cases of domestic violence), except called for by the Governor of that State, or by its Legislature when it is in session.

The Federal forces may, however, enter a State of its own motion in case of invasion by a foreign power and insurrection against Federal authority, and may always act in the protection of Government property and to prevent interference with the mails.

Notes on Military Science.

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